MEASURING PROGRESS ON ADAPTATION AND CLIMATE RESILIENCE: RECOMMENDATIONS TO THE GOVERNMENT OF CANADA

Expert Panel on Climate Change Adaptation and Resilience Results

Canada

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This report is a product of the Expert Panel on Climate Change Adaptation and Resilience Results, comprised of members from Indigenous organizations and governments, academia, the private sector, government, non-governmental organizations, and youth organizations. The Expert Panel was established to provide advice to the Government of Canada on measuring progress on adaptation and climate resilience.

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Blair Feltmate

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The Expert Panel's report does not necessarily reflect the views of each member's organization.

The report as a whole represents the collective expertise of the Expert Panel. The Expert Panel is providing this advice with the intention that it could serve as a foundation for future work related to measuring progress on adaptation and climate resilience in Canada.

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Message from the Chair

The mandate of the Expert Panel on Climate Change Adaptation and Resilience Results was to propose indicators to measure progress on adaptation reflective of the five priority areas identified in the Pan-Canadian Framework on Clean Growth and Climate Change. Following approximately eight months of deliberation, this document presents the indicators collectively derived by the Expert Panel.

Members of the Expert Panel – drawn from Indigenous organizations and governments, academia, the private sector, capital markets, municipal governments, non-governmental organizations, and youth organizations – were all active participants in informed and respectful discussions that led to reducing long lists of indicators down to the 54 described in this report. The indicators are both qualitative and quantitative, and the Expert Panel limited the number to as many as necessary to assess adaptation as profiled in the Pan-Canadian Framework.

Expert Panel members felt strongly that the indicators must show respect for, and take into consideration, scientific information and Indigenous Knowledge Systems in equal measure – this philosophy was reflected in all discussions and meetings of the Expert Panel.

Recognizing that climate change is not static, in the concluding chapter of this report the Expert Panel focuses on recommendations essential to monitoring and evaluating continuous improvement on adaptation within Canada.

I thank Expert Panel members for volunteering their time and energy to this process, and for working diligently to develop both the indicators and related advice the report conveys. Similarly, the contributions of both the federal secretariat and consultants that helped to guide productive discussions throughout the process cannot be overstated.

On behalf of Expert Panel members, I am confident that direction presented in this report will make a material contribution to the ongoing challenge of measuring progress on adaptation and climate resilience, and in so doing it will serve to benefit all Canadians.

Respectfully,

B. Feltmate

Dr. Blair Feltmate
Chair, Expert Panel on Climate Change Adaptation and Resilience Results

Executive Summary

Climate change impacts are being felt across Canada in significant ways. With observed increases in average temperature and precipitation over the last six decades, including especially rapid rates of warming in the North, climate change is already affecting Canada's environment and economy, as well as the safety, physical, mental, cultural, and spiritual health and well-being of Canadians. As these impacts are projected to intensify in the coming decades, it is essential that Canadians act now to adapt and build their resilience to climate change.

To help to overcome the challenges associated with climate change in Canada, actions to adapt and build climate resilience are being carried out across the country, by all levels of government, as well as by non-governmental organizations, Indigenous Peoples, the private sector, academia, professional organizations, and individual Canadians. These actions are crucial for building Canada's capacity to thrive under new climate conditions. However, effectively managing climate risks requires coherence and high levels of coordination between actions that result from an understanding of Canada's overall progress on adaptation and climate resilience, including to what extent collective action and investments are building adaptive capacity. A robust approach to evaluating progress is needed to increase understanding, support informed decision-making and continuous improvement, and ultimately, enhance climate resilience.

The Expert Panel on Climate Change Adaptation and Resilience Results was launched by the federal government in August 2017 to advise the Government of Canada on measuring overall progress on adaptation and climate resilience. The Expert Panel was asked to recommend a suite of indicators to measure progress on adaptation and climate resilience in Canada. The recommended indicators were to align with the five key areas of action identified under the adaptation and climate resilience pillar of the Pan-Canadian Framework on Clean Growth and Climate Change, Canada's national plan to address climate change, build resilience, and grow the economy. It is under this framework that the Expert Panel, following an ambitious, eight-month process of discussion and deliberation, proposes a suite of 54 indicators across the following five chapters:

Protecting and Improving Human Health and Well-Being, focused on the key determinants of health as they relate to climate change impacts, and objectives and indicators that could be used to monitor and evaluate progress toward increasing the resilience of people, communities, and health practitioners to a broad range of health impacts associated with climate change;

Supporting Particularly Vulnerable Regions, focused on Canada's northern, coastal, and remote regions and objectives and indicators to measure the resilience of these particularly vulnerable regions to slow-onset climate change impacts (e.g., permafrost thaw, coastal erosion);

Reducing Climate-Related Hazards and Disaster Risks, focused on objectives and indicators related to reducing impacts from rapid-onset climate-related events (e.g. floods, wildfires and other events), aligned with the four components of emergency management: prevention, preparedness, response and recovery;

Building Climate Resilience through Infrastructure, focused on objectives and indicators to measure the resilience of Canada's traditional, cultural, and natural infrastructure, new and existing infrastructure, critical and non-critical infrastructure, and the interdependencies of its infrastructure systems; and

Translating Scientific Information and Indigenous Knowledge into Action, focused on objectives and indicators related to the respectful consideration and use of Indigenous Knowledge Systems and science to co-develop information related to climate change impacts, build the capacity of Canadians to act on this information, and mobilize action on adaptation.

The indicators recommended within these chapters are diverse and are intended to identify and measure key elements that would reflect progress on adaptation and climate resilience in Canada. While the full suite is appropriately broad, consistent with the scale, scope, and complexity of the climate change challenge, the Expert Panel has identified a sub-set of 19 indicators from within the larger set that could serve as a starting point for future discussion and work on measuring progress on adaptation and climate resilience, including consideration of a measurement program for adaptation and climate resilience in Canada (see Table 1).

In addition to advising on proposed indicators, the Expert Panel also considered how to implement a sustainable approach to monitoring progress on implementation. Chapter 7 of this report details an approach to mobilizing the Expert Panel's proposed indicator suite through a sustainable, robust, broadly applicable monitoring and evaluation framework.

In this context, the report highlights several elements essential to implementation of a monitoring and evaluation program for adaptation and climate change resilience in Canada, including:

> The importance of **working with Indigenous Peoples and Indigenous Knowledge Systems** to measure progress on adaptation and climate resilience and respond to the results from monitoring and evaluation; and
>
> The need for **continuous improvement** to both the indicator set and monitoring and evaluation program, necessary to reflect the rapid evolution of climate change science and the information and results of monitoring and evaluation efforts.

Building on the abovementioned chapters, the Expert Panel has also included a *Call to Action*. This highlights the vital importance and urgent need for action to build climate resilience in Canada complementary to and aligned with actions to mitigate climate change and calls on all orders of government to build on the Expert Panel process, working in close collaboration with Indigenous Peoples, the private sector, communities, non-governmental organizations, professional associations, academia and civil society.

Table 1. Expert Panel Objectives and Sub-Set of Indicators (for full list of recommended indicators, see Chapters 2-6 or Appendix II)

Chapter	Objectives	Indicator Sub-Set
Protecting and Improving Human Health and Well-Being	Reduce vulnerability by decreasing sensitivity to climate impacts through alleviating the conditions that make high-risk populations more vulnerable to health-related climate impacts	Percentage of Canadians living on low incomes in climate hazard areas **(Indicator #2)** Number of culturally appropriate public awareness and education campaigns to promote personal protection from climate change health effects **(Indicator #4)** Number of health care practitioners trained to identify and respond to climate-related health effects (including doctors, nurses, social workers, first responders, pharmacists, etc.) **(Indicator #8)**
	Increase at-risk Canadians' ability to monitor and intervene to reduce their vulnerability to the health impacts of a climate-related hazard	
	Ensure adequate responses to health-related climate impacts for those for whom the climate hazard could not be eliminated	
Supporting Particularly Vulnerable Regions	Increase northern, remote, and coastal regions' understanding of slow-onset events	Percentage of communities in northern, remote, and coastal areas with community-based, specialized (e.g., coastal erosion, permafrost thaw, etc.) environmental monitoring programs that incorporate climate/weather observations **(Indicator #10)** Number of key members of community (e.g., police, firefighters, water technicians, harvesters) with safety training and equipment to adapt to changing conditions **(Indicator #13)** Maximum response times in northern, remote, and coastal regions related to search & rescue and emergency response programming **(Indicator #14)** Percentage of people in northern, remote, and coastal communities whose access to the land, including country foods and traditional ways of life, is impacted by slow-onset events **(Indicator #15)**
	Reduce the sensitivity of northern, remote, and coastal regions to slow-onset events	
	Increase the adaptive capacity of northern, remote, and coastal regions by providing the human, technical and financial resources to self-determine their response to slow-onset events	
	Improve regional collaboration between governments, communities, Indigenous Peoples, the private sector, and other relevant stakeholders (including agreements like Memoranda of Understanding (MOUs) and Data Sharing, which facilitate data access)	
Reducing Climate-Related Hazards and Disaster Risks	Prevent and reduce exposure to hazards exacerbated by climate change while recognizing limitations of existing built environment	Percentage or number of communities with development and re-development 'build back better' control policies, bylaws and regulatory tools for climate-related hazards that are culturally appropriate and include Indigenous Knowledge Systems where
	Increase preparedness for emergency response to hazards	

	exacerbated by climate change while involving high-risk vulnerable population representatives Improve the efficiency and equity of emergency response to future climate-related hazard events Improve efficiency and resilience during recovery following climate-related hazard events	appropriate **(Indicator #19)** Percentage or number of culturally and locally relevant emergency response warning systems focusing on high-risk vulnerable populations **(Indicator #27)** Number of people directly affected by a climate-related disaster **(Indicator #29)** Percentage of total financial losses restored, making citizens whole **(Indicator #31)**
Building Climate Resilience through Infrastructure	Integrate climate resilience into policies, bylaws, plans and other planning mechanisms that direct development, affect safety, determine placement of infrastructure and consider interdependencies Integrate climate resilience into infrastructure investments Protect and enhance natural and cultural assets and better integrate them into design, planning and investment decisions to enhance community and ecosystem resilience Maintain or improve levels of infrastructure services considering a changing climate	Number of codes and standards reviewed, updated and developed across the full breadth of climate hazard types and asset types at risk, including Indigenous-specific building programs **(Indicator #33)** Percentage of total government infrastructure spending directed to building resilience towards locally-identified high priority climate risks (as identified by community climate vulnerability assessments) **(Indicator #37)** Percentage of communities (regional, municipal, Indigenous Peoples) that have natural and cultural asset management plans **(Indicator #40)** Number of infrastructure owners and operators that have integrated climate resilience into their planning, infrastructure investments, operations and strategy **(Indicator #43)**
Translating Scientific Information and Indigenous Knowledge into Action	Indigenous Knowledge and science systems are invested in and respectfully utilized equally and/or together for adaptation knowledge production Canadian individuals and organizations have increased capacity for participation in adaptation Climate change adaptation knowledge is being translated into action and implemented in plans and practices at multiple levels and	Number of community-based climate-related monitoring and adaptation programs that include Indigenous, local and scientific knowledge **(Indicator #44)** Amount of federal, territorial/provincial or municipal funds invested in development of up to date, accessible, relevant, co-produced, localized, equitably distributed information on climate and environmental data for both regions and sectors that can be used to support planning and decision making **(Indicator #45)**

	scales	Number of training or capacity building programs that demonstrate the application of Indigenous Knowledge Systems and/or scientific information in the context of climate change adaptation **(Indicator #48)** Extent of each province and territory covered by adaptation plans incorporating climate risk assessments, designed to be updated every 5 years **(Indicator #50)**

Call to Action

The need to become more resilient to a changing climate is increasingly apparent to Canadians. Adequately managing climate risks requires measurement of the effectiveness of efforts to adapt. The dynamic nature of climate change against a backdrop of an ever-changing society requires a robust monitoring and evaluation (M&E) system and learning over time to enhance adaptive capacity. Given the complexity and pervasive nature of climate change and its impacts, it is challenging to develop a manageable and implementable suite of indicators. However, making marked improvements to Canada's resilience to climate change is critical.

Through this report, and because of the imperative for increased action, we issue a call to action by all orders of Canadian government to work in concert with Indigenous Peoples, the private sector, and civil society to build on this work and apply it to their own specific circumstances.

> *Indicators represented in the final list for this report comprise a small fraction of the total suite of indicators developed by the Expert Panel. The list has been reduced significantly to advance a manageable suite to support implementation. The Expert Panel struggled to maintain the balance between a manageable number of indicators and what is required to adequately assess adaptation and resilience in Canada. As a result, we recommend that implementation of an M&E program recognize the importance of expanding and tailoring the indicator suite to fill gaps over time.*
>
> *The adaptation indicators were developed to align with the areas of action in the adaptation and climate resilience pillar of the Pan-Canadian Framework on Clean Growth and Climate Change. As such, these areas of action provide the primary framework for reporting results. However, the Expert Panel recognizes that other themes for monitoring and evaluation may be more appropriate and enable more discrete (Indigenous Peoples, regions, sectors, governments) implementation of the M&E program. Application of a measurement program using other themes may help identify coordination and efficiency in measurement and areas for addition of subsequent indicators. The Expert Panel also recognizes that ecosystems and climate-sensitive sectors such as agriculture and forestry are under-represented in the Pan-Canadian Framework on Clean Growth and Climate Change, thus do not have accompanying indicators.*
>
> *The diversity of representation and rich experience of Expert Panel members brought broad perspectives and fulsome dialogue to the process of developing indicators for measuring adaptation and climate resilience in Canada. However, the Expert Panel stresses the importance of ongoing engagement with Canadians, particularly Indigenous Peoples, the private sector, and civil society, in all aspects of future adaptation monitoring and evaluation, including indicator refinement, data and knowledge gathering, program development and adjustments to adaptation actions.*
>
> *Although the recommended indicators and M&E program are designed to capture and report on adaptation progress at a national level, the Expert Panel encourages uptake of the proposed program for application at other scales – sub-national, local, and institutional.*
>
> *Disparate conditions in rural, remote, northern and coastal communities often pose significant barriers to planning for, and management of, the impacts of changing climate. Indigenous Peoples, notably in northern Canada where climate change is most significant, have led in adaptation, often*

with significantly fewer resources. While building adaptive capacity is an inherent component of adaptation, social and economic deficits and in some circumstances, lack of basic necessities prohibits consideration of adaptation. For these vulnerable populations and regions, climate change adaptation will be enabled by the improvement of basic living conditions.

While the focus for this report is on monitoring and evaluating progress on climate change adaptation, the Expert Panel stresses the importance of Canada's role in mitigating greenhouse gas (GHG) emissions and advocates for resilience measures that reflect the transition to a low carbon society.

Adapting to climate change is a cyclic and continuous planning process, where each step enables subsequent action along a path to implementation and measurement. Equally, monitoring and evaluation of progress in each step implies some order for application of indicators. Indicators for monitoring and evaluation of adaptation should recognize the need for measurement for distinct stages of the adaptation process and report on results in all aspects of adaptation planning.

Introduction

The impacts of climate change are being observed across Canada. *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation* (Warren and Lemmen, 2014) highlights that between 1950 and 2010, average temperatures over land in Canada increased by approximately 1.5°C, with even higher rates of warming in many areas of Canada's north. Canada is also experiencing more extreme heat, with the annual average number of extreme heat days increasing over the same period. In addition, the report notes that Canada's overall average annual precipitation increased between 1950 and 2010, and that both heavy precipitation and extreme precipitation events are projected to become more frequent. Rapid decreases in the extent of glaciers in both western Canada and the Arctic, as well as in Arctic sea ice, have also occurred (Warren and Lemmen, 2014).

These and other climate change impacts occurring across the country pose significant risks to Canadians' health, safety and well-being, as well as to Canada's economy and environment. For instance, most regions of Canada are expected to see an increase in the extent and severity of forest fires, and the projected rise in the number of heavy precipitation events increases the risk of flooding (Warren and Lemmen, 2014). In addition to the substantial insurable losses associated with extreme weather, these events can have significant impacts on Canadians' safety and well-being. For example, 90,000 people were displaced from their homes because of the 2016 wildfire in Fort McMurray, Alberta.

The risks associated with climate change highlight the growing need for effective action on climate change adaptation in Canada. Adaptation can help to protect against these risks, through informed action and decision-making that builds climate resilience, or the ability to thrive under new climate conditions. In addition, adaptation measures can increase Canada's capacity to take advantage of new opportunities. Adaptation helps build a more resilient Canada, reducing harm and lowering the long-term costs associated with climate change.

Climate change adaptation is a shared responsibility, and involvement by all levels of government, Indigenous Peoples, non-governmental organizations, the private sector, and individuals, is crucial. Consistent with this, action to build climate resilience is currently being undertaken in Canada through several measures, by different actors, and at a range of scales. For instance, the federal government is working with provinces and territories to deliver climate change action, including climate resilience, through the Pan-Canadian Framework on Clean Growth and Climate Change (see Box 1). Canadian municipalities play a key role in climate change adaptation as part of municipal planning, including through incorporating adaptation considerations in land-use and infrastructure decision-making and encouraging action at the local level. Indigenous Peoples are active drivers and agents of change, contributing knowledge, experience, and leadership vital to understanding and building climate resilience in Canada.

Box 1: The Pan-Canadian Framework on Clean Growth and Climate Change

The Pan-Canadian Framework on Clean Growth and Climate Change was adopted on December 9, 2016 and sets out a national plan for meeting Canada's GHG emissions reduction target, building resilience to the impacts of climate change, and enabling clean growth and jobs through investments in technology, innovation, and infrastructure. Recognizing that adaptation is an ongoing and long-term challenge, adaptation and climate resilience is one of the four pillars of the Pan-Canadian Framework on Clean Growth and Climate Change.

As we consider the range of climate change adaptation measures underway, it is important to understand how progress on enhancing climate resilience in Canada can be measured and monitored. Developing methods of measuring progress is essential for ongoing learning, informing the evidence base to improve programming, identifying gaps and supporting decision-making. This need is particularly acute in the context of climate change adaptation, as the multi-faceted nature of climate change risks in Canada highlights the need for flexibility and ongoing adjustment.

However, measuring progress on adaptation, including identifying its successes and failures, is complex. Adaptation takes many forms at many scales, in response to a range of impacts in different sectors, regions, and populations. Further, adaptive capacity—or the ability to adapt—varies greatly across the country.

No standard methodology exists for evaluating adaptation, and while many countries (such as the United Kingdom, Germany, and Finland) have developed processes to measure progress in this context, the variable approaches, goals, timelines, and scales of adaptation actions make it difficult to develop single, uniform indicators to measure progress. A suite of qualitative and quantitative indicators is required to reflect the complexities and uncertainties inherent in climate change impacts and adaptation.

To help address the challenges of measuring progress in this context, the Government of Canada launched an external Expert Panel on Climate Change Adaptation and Resilience Results (Expert Panel) on August 29, 2017. The Expert Panel, coordinated federally by Environment and Climate Change Canada in collaboration with other government departments, was asked to recommend to the federal government a series of indicators that could be used to measure progress in Canada on adaptation and climate resilience. The Expert Panel has now concluded its process, and this report, *Measuring Progress on Adaptation and Climate Resilience: Recommendations to the Government of Canada*, represents the Expert Panel's advice.

The following sections detail the Expert Panel's composition and process and provide an overview of the organization of this report.

Membership

The Expert Panel consisted of 22 members, from academia, the private sector, government, non-government, a youth organization, and Indigenous organizations and governments (see member list provided in Appendix I). It was chaired by Dr. Blair Feltmate, head of the Intact Centre on Climate Adaptation at the University of Waterloo.

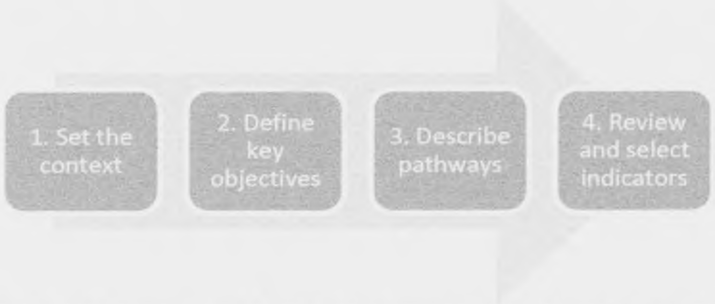
Representatives from the Assembly of First Nations, Inuvialuit Regional Corporation, and Métis National Council played an instrumental role in educating other members about the impacts of climate change on First Nations, Inuit, and the Métis Nation. For more on the importance of Indigenous Knowledge Systems to the Expert Panel process, see the Process section below.

The Expert Panel was supported by a federal secretariat, consisting of officials from Environment and Climate Change Canada, Crown-Indigenous Relations and Northern Affairs, Health Canada, Indigenous Services Canada, Infrastructure Canada, Natural Resources Canada, Public Safety Canada, the Standards Council of Canada, and Statistics Canada.

Process

One of the Expert Panel's first tasks in developing the recommended suite of indicators was to define the context for its work (e.g., what, why, who). A precursor of this process involved designing key objectives, which was followed by a review and selection of indicators that could be used to track progress against the previously identified objectives. This process is illustrated in Figure 1 below.

Figure 1: Steps in developing a suite of indicators



To take advantage of the Expert Panel's collective expertise, the Expert Panel self-selected into six writing teams. Each team was responsible for a chapter of the report, with one or two Expert Panel members identified as chapter leads, and was supported by a federal secretariat member. Writing teams were responsible for developing objectives and indicators for their respective chapters, which were considered by the broader Expert Panel during four face-to-face meetings and numerous teleconference calls.

As Expert Panel members developed the suite of indicators, they explored factors directly related to preparing for and adapting to the impacts of climate change. For instance, an indicator on the extent of critical infrastructure located in locally-identified high-risk climate hazard areas is recommended in Chapter 5: Building Climate Resilience through Infrastructure, as exposure of critical infrastructure to known climate hazards undermines climate resilience. However, Expert Panel members also considered factors for which the linkage to climate change is not as readily obvious. For instance, reconciliation was identified by the Expert Panel as an enabling condition for the resilience of Indigenous Peoples to climate change (see Box 2). In addition, Chapter 2:

Box 2: Reconciliation and the Rights of Indigenous Peoples

The Government of Canada is working to advance reconciliation and renew the relationship with Indigenous Peoples, based on recognition of constitutionally protected rights, respect, cooperation, and partnership. In this context, and as outlined in the Pan-Canadian Framework on Clean Growth and Climate Change, efforts on adaptation must be more inclusive and meaningful and move toward a model of collaborative decision-making.

To fulfill Canada's commitment to a renewed nation-to-nation, government-to-government, and Inuit-to-Crown relationships with First Nations, the Métis Nation, and Inuit, sustained and meaningful collaboration must recognize the rights and interests of Indigenous Peoples as set out in Canada's Constitution. This approach is consistent with the Government of Canada's support for the United Nations Declaration on the Rights of Indigenous Peoples.

Protecting and Improving Human Health and Well-Being highlights the role that social vulnerability can play in reducing climate resilience, recommending an indicator related to social support for high-risk populations. Enabling factors such as levels of social support, while not always directly or singularly related to preparing for or adapting to the impacts of climate change, address root causes of climate vulnerability, and are crucial components for building climate resilience.

Due to the leadership of representatives from the Assembly of First Nations, Inuvialuit Regional Corporation, and Métis National Council, Expert Panel members expressed a strong interest and engaged in discussions regarding how to appropriately, respectfully, and meaningfully include Indigenous Knowledge Systems and perspectives of Indigenous Peoples throughout the Expert Panel's deliberations.

Indigenous Knowledge Systems are cumulative, dynamic, and adaptive, intertwined with personal, community, and national/cultural knowledge. Indigenous Knowledge Systems are a "way of being" that is broader than specific ecological knowledge. Indigenous Knowledge Systems are not narrow, static or historic; they continue to be applicable to policy and can support a more comprehensive understanding of threats from climate change and potential solutions. The Expert Panel recognized that adaptation decisions need to be based on both Indigenous Knowledge Systems and scientific information, and the recognition that both ways of knowing can be used in parallel and are of equal value and complementary.

The Expert Panel also agreed that any future efforts to develop a framework for monitoring, evaluating and reporting on progress on adaptation and climate resilience would need to be co-developed with Indigenous Peoples, organizations, and governments to ensure that the measurement system is equitable and recognizes the important role of Indigenous Peoples and Indigenous Knowledge Systems in decision-making.

Organization of the Report

The report opens with a *Call to Action,* which emphasizes the importance of all orders of government – in collaboration with Indigenous Peoples, the private sector, communities, non-governmental organizations, professional associations, academia and civil society – to take action to build climate resilience in Canada, complementary to and aligned with actions to mitigate climate change.

Following the Call to Action and this Introduction, the objectives and indicators recommended by the Expert Panel are presented in five chapters:

- Chapter 2: Protecting and Improving Human Health and Well-Being
- Chapter 3: Supporting Particularly Vulnerable Regions
- Chapter 4: Reducing Climate-Related Hazards and Disaster Risks
- Chapter 5: Building Climate Resilience through Infrastructure
- Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action

These chapters are aligned with the priority areas identified in the adaptation and climate resilience pillar of the Pan-Canadian Framework on Clean Growth and Climate Change, as requested by the Government of Canada. Each of these chapters provides contextual information for the priority area in question and describes objectives and indicators recommended by the Expert Panel.

In addition to developing this suite of indicators, the Expert Panel also considered how best to advise the federal government on establishing a robust adaptation and climate resilience monitoring and evaluation system. The Expert Panel's advice in this context is contained in Chapter 7: Implementing a Sustainable Approach to Monitoring Progress on Adaptation.

Additional details on the recommended indicators, including information on proposed metrics, baselines and limitations, can be found in indicator templates contained in Appendix III.

Chapter 2: Protecting and Improving Human Health and Well-Being

The purpose of this chapter is twofold: to present some of the key determinants of health as they relate to climate change impacts, and to identify indicators that decision-makers can use to monitor and evaluate progress toward increasing the resilience of people and communities to the health and well-being effects of climate change.

To guide the development of this chapter, the authors have applied a holistic view of health, consistent with Indigenous perspectives on health, encompassing the physical and mental well-being of an individual, as well as the social, emotional, and cultural well-being of the whole community, including the environment (land, water, and wildlife) that sustains it (Council of Canadian Academies, 2014). To effectively address health-related climate change impacts, we must look beyond seeing health as solely the absence of illness.

Box 3: The Cree perspective on the physical, mental, and spiritual dimensions of health

Cree peoples' understanding of health is based on an individual's interpersonal relationships and their relationship to nature. *Miyupimaatisiiun* is a Cree word that translates into "being alive well", which is meant to communicate the interconnectivity of all elements of the universe. When understood this way, the health of communities, the environment, and individuals are highly intertwined. Preserving the environment and maintaining social cohesion determine individual health. This understanding of the physical, emotional and spiritual dimensions goes beyond a simplistic view of health signifying the absence of illness.

Source: Hennigs and Bleau (2017)

Context

The effects of climate change threaten the natural, built, and social systems Canadian communities rely on to function (Warren and Lemmen, 2014). The risks climate change poses to human health and well-being are increasingly understood as requiring just as much attention as the need to ensure built infrastructure is resilient (Ove Arup and Partners, 2014). We know, for example, that climate change is directly and indirectly influencing the incidence and severity of illness and deaths related to poor air quality, water-and food-borne contamination, changing patterns of diseases spread by animals, ticks and insects, and extreme weather events, including extreme heat events exacerbated by urban heat islands. Specific challenges and impacts in the North are already being observed, such as more dangerous travel (unusual changes in ice, snow and land conditions), damage to infrastructure and water due to permafrost thaw, threats to traditional food sources, disappearance of drinking water sources and related-psychosocial and cultural impacts (Berry, Clarke, Fleury, and Parker, 2014).

Box 4: Canada's 10 high-risk populations

- Seniors
- Indigenous Peoples
- Low-income residents
- Persons with low literacy levels
- Transient populations
- Persons with a disability
- Medically dependent persons
- Children and youth
- Women
- New immigrants and cultural minorities

Source: Canadian Red Cross Society (2007)

Vulnerability to health-related climate change impacts is often socially determined. Income and social status, social support networks, education and literacy, gender, and culture all influence individual and community capacity to adapt to climate impacts (Cutter, Ash, and Emrich, 2014a; Public Health Agency of Canada, 2011). The 2014 National Climate Assessment acknowledged that all Canadians are at risk from the health impacts of climate change. However, it identified seniors, children and infants, the socially and economically disadvantaged, those with chronic diseases and compromised immune systems, Indigenous Peoples, and residents of northern and remote communities as being more vulnerable (Berry et al., 2014). For consistency with the definition used in Chapter 4: Reducing Climate-Related Hazards and Disaster Risks, the Canadian Red Cross Society (Canadian Red Cross Society, 2007) identified 10 groups in Canada at high risk during emergencies; it can be extrapolated that these groups should be at the centre of programming to reduce human health and well-being effects of climate change (see Box 4).

Table 2: Direct and indirect health-related climate change effects adapted from Human Health; *in* Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation (adapted from Berry et al., 2014)

Health Impact Categories	Potential Changes	Projected/Possible Health Effects
Temperature extremes	• More frequent, severe and longer heat waves • Overall warmer weather, with possible colder conditions in some locations	• Heat-related illnesses and deaths • Respiratory and cardiovascular disorders • Possible changed patterns of illness and death due to cold
Extreme weather events and natural hazards	• More frequent and violent thunderstorms, more severe hurricanes and other types of severe weather • Heavy rains causing mudslides and floods • Rising sea levels and coastal instability • Increased drought in some areas, affecting water supplies and agricultural production, and contributing to wildfires • Social and economic changes	• Death, injury and illness from violent storms, floods, etc. • Psychological health effects, including mental health and stress-related illnesses • Health impacts due to food or water shortages • Illnesses related to drinking water contamination • Effects of the displacement of populations and crowding in emergency shelters • Indirect health impacts from ecological changes, infrastructure damages and interruptions in health services
Air quality	• Increased air pollution: higher levels of ground-level ozone and airborne particulate matter, including smoke and particulates from wildfires • Increased production of pollens and spores by plants	• Eye, nose and throat irritation, and shortness of breath • Exacerbation of respiratory conditions • Chronic obstructive pulmonary disease and asthma • Exacerbation of allergies • Increased risk of cardiovascular diseases (e.g. heart attacks and ischemic heart disease) • Premature death

Contamination of food and water	• Increased contamination of drinking and recreational water by run-off from heavy rainfall • Changes in marine environments that result in algal blooms and higher levels of toxins in fish and shellfish • Behavioural changes due to warmer temperatures resulting in an increased risk of food- and water-borne infections (e.g. through longer BBQ and swimming seasons) • Increased economic pressures on low income and subsistence food users	• Sporadic cases and outbreaks of disease from strains of water-borne pathogenic micro-organisms • Food-borne illnesses • Other diarrheal and intestinal diseases • Impacts on nutrition due to availability of local and traditional foods
Infectious diseases transmitted by insects, ticks and rodents	• Changes in the biology and ecology of various disease-carrying insects, ticks and rodents (including geographical distribution) • Faster maturation for pathogens within insect and tick vectors • Longer disease transmission season	• Increased incidence of vector-borne infectious diseases native to Canada (e.g. eastern & western equine encephalitis, Rocky Mountain spotted fever) • Introduction of infectious diseases new to Canada • Possible emergence of new diseases, and re-emergence of those previously eradicated in Canada
Stratospheric ozone depletion	• Depletion of stratospheric ozone by some of the same gases responsible for climate change (e.g. chloro- and fluorocarbons) • Temperature-related changes to stratospheric ozone chemistry, delaying recovery of the ozone hole • Increased human exposure to UV radiation owing to behavioural changes resulting from a warmer climate	• More cases of sunburns, skin cancers, cataracts and eye damage • Various immune disorders

High-risk populations often suffer greater effects to health and well-being as a result of climate: flooding is devastating to households lacking financial resources; Indigenous Peoples and remote communities have limited access to culturally appropriate health services and emergency response programs; low-income families have reduced access to funds to replace spoiled food; older adults are more vulnerable to extreme heat and may face challenges getting relief from heat as a result of mobility challenges, social isolation, and visual or hearing impairments (see Box 5).

Box 5: Hurricane Katrina: A case study of the intersection between vulnerability, exposure, and health impacts

The impacts associated with Hurricane Katrina were felt differently by different social groups. An individual's race, gender, or class influenced their level of social vulnerability, including their level of adaptive capacity. This meant that while some could cope easily with the effects of the hurricane, others did not have the resources or capacities to adequately prepare or respond to the emergency.

The lack of affordable housing led to an increase in social vulnerability as families lived in housing that was older, and in poorer condition. Although households were asked to prepare (e.g., via the purchase of hurricane shutters), those with lower incomes were less likely to be able to do so, given the demands of their daily lives. Similarly, many vulnerable groups lacked the financial and physical means by which to evacuate, as well as the financial resources to provide a cushion during a long response period (Laska and Morrow, 2006).

The United Nations Department of Economic and Social Affairs (UNDESA) suggests that climate change and social vulnerability are locked in a vicious cycle, whereby climate hazards aggravate the socio-economic inequalities that underpin exposure and vulnerability, leading to high-risk groups experiencing disproportionate losses in terms of their lives and livelihoods (United Nations Department of Economic and Social Affairs, 2016). If this cycle is left unaddressed, climate impacts will perpetually erode adaptive capacity by deepening vulnerability in high-risk populations.

There are important synergies, therefore, between efforts to address social vulnerability, and efforts to increase climate resilience. The value of social capital is a case in point. Social capital is a measure of social cohesion, agency, trust, and social learning (Walker et al., 2014). Improving health and well-being by increasing social capital and decreasing social isolation is a crucial adaptation strategy that can minimize the health impacts of climate change (Cheng and Berry, 2013). Belonging to a social network can increase capacity to respond to health-related climate impacts, including those experienced during and after extreme events. This was seen in New Jersey after Hurricane Sandy, where trust between neighbours enabled them to share essential resources in the absence of immediate government support (The Associated Press-NORC Center for Public Affairs Research, 2014). In New Brunswick, an intense ice-storm in January 2017 left residents on the Acadian Peninsula without power for up to 10 days. The event exposed the compounding effects of poverty, isolation and climate change. Door-to-door checks by volunteers uncovered a surprising number of people who were "insecure, frightened, and isolated," according to a CBC interview with Jackie Plourde, pastoral assistant at the Notre-Dame-des-Flots church in Lamèque, New Brunswick (Fahmy, 2017). In response to the lack of government support, parishioners in Lamèque have increased their social capital through new programs and a community kitchen specifically targeting people identified during the ice storm.

In the same way, adaptation strategies that increase access to savings, insurance instruments (e.g., tenancy insurance), and/or diversified assets can also reduce exposure of high-risk populations to climate-related events (United Nations Department of Economic and Social Affairs, 2016) as they help to mitigate the financial consequences – and related health impacts of stress, anxiety, and depression – resulting from climate impacts. Reducing the vulnerability of high-risk populations to climate change impacts on health is essential for increasing both their own adaptive capacity and the overall resilience of urban and rural communities and Indigenous Peoples (Cox and Hamlen, 2015; Gonzalez, James, and Ross, 2017; Guilbault, Kovacs, Berry, and Richardson, 2016). Efforts to reduce social vulnerability in relation to climate hazards and disasters must be combined with efforts to increase resilience in built and natural systems if we are to achieve durable resilience and well-being (Cutter et al., 2014b; da Silva, Kernaghan, and Luque, 2012;

Public Health Agency of Canada, 2017). This necessarily involves reconciling with Indigenous Peoples, confronting economic inequality, and a host of other activities that are increasingly essential to resilience building efforts.

Considerations for Measuring Progress

Despite what appear to be static categories of high-risk populations, vulnerability is highly context specific, influenced by temporal and geographic factors. Vulnerability also varies greatly among and within communities (Cox and Hamlen, 2015). It is difficult, therefore, to use only quantitative methods to assess health and well-being vulnerability due to climate change, as by definition people and communities are not homogeneous in terms of their adaptive capacity or sensitivity to a given impact. For example, a person's vulnerability might change over the course of a brief period, and two people in the same high-risk population category are likely to have varying levels of actual vulnerability. Despite the challenges, building climate resilience requires responses to social vulnerability. Across Canada, an increasing number of vulnerability assessments that account for high-risk populations are being conducted; these are being done to assess social vulnerability and are being carried out nationally and at the neighbourhood or community scale by local governments or health authorities.

Recommendations

As already noted, it is impossible to disaggregate the health and well-being effects of climate change from the social conditions that make the consequences of these impacts so profoundly different for various groups. As a result, the proposed indicators represent a framework for minimizing health-related climate impacts. By addressing the first objective (i.e., reducing vulnerability), we can reduce Canadians' sensitivity to the effects of climate change and, by extension, the number of people requiring a health- or emergency-care based response. Correspondingly, failure to reduce vulnerability means that more people will experience the negative health and well-being effects from climate change and require a response.

Objective 1: Reduce vulnerability by decreasing sensitivity to climate impacts through alleviating the conditions that make high-risk populations more vulnerable to health-related climate impacts

This objective focuses on addressing the compounding conditions that affect resilience to the health effects of climate change and the capacity to adapt. It aims to ensure people are resilient to begin with, by focusing on alleviating the conditions that make people more affected by climate change impacts.

1. **Proportion of climate change vulnerability assessments that consider high-risk populations (i.e., high-risk populations as identified by the Canadian Red Cross)**

To effectively prepare for the health impacts of climate change, information about the risks posed by current climate variability, the possible impacts associated with future climate change, the unique vulnerabilities facing specific populations, communities or regions, and effective measures to protect health is required. Completing climate change vulnerability assessments that consider high-risk populations will support authorities in identifying and interpreting information needed to implement interventions to help reduce health-related climate impacts among these populations.

2. **Percentage of Canadians living on low incomes in climate hazard areas**

Income and social status influence individual and community capacity to adapt to climate impacts. When hit by climate hazards, people afflicted by poverty suffer great losses in terms of lives and livelihoods. The inequitable impact of climate hazards further aggravates existing socioeconomic inequalities and undermines the capacity of people to cope and adapt.

3. Percentage of high-risk Canadians living in hazard areas with social support and response systems in place

Social capital plays a critical role during disasters and extreme weather events such as those associated with climate change; elevated levels of social capital can help residents survive climate-related disasters and accelerate recovery and long-term adaptation. Social capital motivates residents to return to damaged areas and to petition political leaders for assistance in handling challenges (Aldrich, 2010). Individuals with strong social ties to neighbours, feelings of attachment and place, and a vision for their neighbourhood's future are more likely to return and restore a damaged neighbourhood (Aldrich, Page, and Paul, 2016).

Objective 2: Increase at-risk Canadians' ability to monitor and intervene to reduce their vulnerability to the health impacts of a climate-related hazard

This objective focuses on actions to detect early evidence of changes in health risk or status, followed by specific targeted action to address risks.

4. Number of culturally appropriate public awareness and education campaigns to promote personal protection from climate change health effects

Personal preparedness against climate change health effects is a vital component of health promotion. Irrespective of the actions taken by local, sub-national, and national governments, individuals need to take actions to promote their own personal protection from climate change health effects. This indicator measures Canadians' access to the resources or capacities needed to adequately prepare themselves or respond to climate impacts.

5. Area covered by surveillance programs for water-, food- and vector-borne diseases

Effective surveillance is often considered the foundation of public health systems and a key component of evidence-based health decision-making. Adapting or expanding surveillance programs to better incorporate the surveillance of the health threats associated with climate change has consistently been identified as a priority action for Canada's health sector.

This indicator assesses the area of Canada currently covered by surveillance programs designed to identify health risks associated with climate change impacts on water-, food- and vector-borne diseases.

6. Number of culturally-appropriate programs that identify mental health effects resulting from climate hazards

This indicator documents the number of culturally-appropriate programs that identify mental health effects resulting from climate risks. The rationale for documenting this indicator is to understand the risks, vulnerabilities, and impacts of climate change on mental health and to reduce the mental health effects of climate change. Documenting this indicator supports an equity-focused approach to building resilience to the climate change impacts to mental health.

7. Proportion of health care facilities that have emergency and management plans that include climate hazards (i.e., inclusion of on-site back-up energy sources, back-up water access, alternate access routes, emergency shelters, etc.)

Climate change poses risks to health care facilities in the same way it does to any other institution or business (i.e., operational disruption, physical damage, service interruption, etc.). For example, extreme weather can damage hospital infrastructure, disrupt power supplies, compromise the availability of critical resources and place greater demands on health care staff and affect patient safety. Health care facilities can manage these risks in part through effective emergency response and/or management plans that incorporate climate change considerations within them. These plans should be tested and revised in regular intervals to inform stakeholders and consider the latest climate information, building systems, and operational activities.

Objective 3: Ensure adequate responses to health-related climate impacts for those for whom the climate hazard could not be eliminated

This objective addresses actions taken to lessen negative health outcomes or mortality caused by climate impacts.

8. Number of health care practitioners trained to identify and respond to climate-related health effects (including doctors, nurses, social workers, first responders, pharmacists, etc.)

Across Canada climate change is increasing direct and indirect health risks to Canadians. Gradual warming of the climate and more severe and frequent extreme weather events can result in the emergence of new health risks and the exacerbation of existing ones in communities across Canada. Health care professionals (doctors, nurses, social workers, first responders, pharmacists, etc.) should be properly trained to identify and treat these threats, to protect the health and well-being of Canadians. This indicator documents progress towards equipping the health-related workforce with the skills needed to protect Canadians from the health impacts of climate change.

9. Number of first responder support programs capable of addressing the physical and mental stresses associated with climate-related hazards

First responders, those who respond to disasters and emergencies, serve the needs of others and place themselves at risk for physical and psychological harm. Accordingly, it is important to enhance their experience of personal and professional growth, while ensuring protective systems are in place to prevent avoidable distress and harm (Quevillon, Gray, Erickson, and Jacobs, 2016).

This indicator documents progress made in ensuring first responder support programs integrate core components to enhance resilience in responding to the physical and mental health consequences first responders experience in their ongoing work to protect Canadians from the impacts of climate change.

Chapter 3: Supporting Particularly Vulnerable Regions

All regions in Canada face unique risks, challenges, and opportunities due to climate change. The Pan-Canadian Framework on Clean Growth and Climate Change identifies Indigenous Peoples, as well as northern, remote, and coastal regions, as "particularly vulnerable and disproportionately affected by the impacts of climate change" (Environment and Climate Change Canada, 2016, p. 33).

Vulnerability varies over time and space, so this chapter begins by conceptualizing vulnerability. Using this conceptualization and the Pan-Canadian Framework on Clean Growth and Climate Change definition of "vulnerable regions", we identify northern, coastal, and remote regions as "vulnerable regions" for the purposes of this chapter. This process of conceptualizing vulnerability will improve understanding of the regions' unique vulnerabilities, enabling the chapter to outline possible indicators of adaptation efforts, including those led by communities.

This chapter focuses predominantly on the slow-onset or chronic conditions, such as thawing permafrost or sea level rise, that northern, remote, and coastal regions face (which, if not proactively addressed, can also become acute events or disasters). For example, thawing permafrost, after a period, could potentially result in a landslide. These experiences and the proposed solutions to help lessen the vulnerability of these regions should be used as a test of resilience for the rest of Canada. Note that vulnerabilities experienced by ten identified high-risk, vulnerable populations were addressed in Chapter 2: Protecting and Improving Human Health and Well-Being.

Context

As the Pan-Canadian Framework on Clean Growth and Climate Change outlines, "action taken to support adaptation in vulnerable regions can help communities, traditional ways of life, and economic sectors endure and thrive in a changing climate... [and] benefit other vulnerable regions and sectors" (p.33). This chapter aims to identify indicators to measure resilience for northern, coastal, and remote regions against slow-onset climate events. Slow-onset events indicate impacts that can be felt immediately and could be catastrophic in the future if no actions are taken. Thus, adaptive measures must be implemented as soon as possible to prevent catastrophic damages, failures, and loss of life.

Given that these regions are disproportionally affected by the impacts of climate change, understanding how resilience is changing in vulnerable regions can also serve a broader purpose of informing understanding of how resilience is changing across Canada. In this context, northern, remote and coastal regions should be seen as a test of resilience across Canada, and best practices identified in these regions can inform action in other regions.

What is vulnerability?

Vulnerability changes over time and space due to the variability of spatial, temporal, and social groups (Cutter, Boruff, and Shirley, 2003). As a result, assigning "vulnerability" is often dependent on how exactly vulnerability has been interpreted. For the purposes of this chapter, we interpret vulnerability in accordance with the Intergovernmental Panel on Climate Change (IPCC) as the "propensity or predisposition to be adversely affected"[1] (IPCC, 2014a). It is a function of three core factors:

- The character, magnitude, and rate of change of climate change impacts to which the system is exposed (**exposure**);
- The **sensitivity** of the system (the degree to which a system could be affected adversely or beneficially by climate change); and
- The **adaptive capacity** of a system (the ability of a system to adjust to climate change, to moderate potential damages, to take advantage of opportunities or to cope with the consequences).

Under this conceptual framework (see Box 6), all regions in Canada are exposed to climate events. This exposure has important socio-economic, environmental, and socio-cultural impacts. But, as mentioned in the context of vulnerable regions in the Pan-Canadian Framework on Clean Growth and Climate Change: (Environment and Climate Change Canada, 2016, p. 33):

> "unlike rebuilding after an extreme event like a flood or a fire, once permafrost has thawed, coastlines have eroded, or socio-cultural sites and assets have disappeared, they are lost forever."

These events can be considered "slow-onset" or chronic, where impacts evolve gradually from incremental changes occurring over many years or from an increased frequency or intensity of recurring events (Siegele, 2012). On the other hand, floods and fires are referred to as "rapid-onset" or acute events, which can be single, discrete events that occur in a matter of days or even hours (United Nations Framework Convention on Climate Change, 2012). While also subject to rapid-onset events, which often have very significant consequences for these regions, northern, coastal, and remote regions are particularly vulnerable to "slow-onset events". Objectives and indicators related to "rapid-onset" events will be considered in Chapter 4: Reducing Climate-Related Hazards and Disaster Risks.

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[1] Noting the argument of Schauser et al., 2010: this definition has limitations and is difficult to operationalize because the precise relationship among the three components is not defined, the terms are not always accurately defined and there is considerable overlap between adaptive capacity and sensitivity.

Box 6: Thinking about Sensitivity and Adaptive Capacity

Sensitivity is the degree to which a given community or ecosystem is affected by climatic stresses. For example, a community dependent on rain-fed agriculture is much more sensitive to changing rainfall patterns than one where mining is the dominant livelihood. To determine sensitivity, think about each impact statement and assess whether it would affect the ability of the community to function or operate normally. To answer this question, consider the current state of the community and how it would be affected if this impact were to occur today. Considerations can include current pressures faced by the community that might increase sensitivity (e.g., existence and current state of infrastructure, diversity within the economic structure, population health), and any conditions that would affect the ability to manage each impact.

Factors Affecting Adaptive Capacity

There are a variety of factors that can affect an individuals or community's adaptive capacity including:

- Economic Resources: Wealthier individuals, communities, and regions are better able to bear the costs of adaptation than poorer ones;
- Technology: Lack of technology (such as access to telecommunications networks) can impede adaptation, while access to such technologies can enhance it;
- Information and Skills: Information and trained personnel are required to assess and implement successful adaptation options;
- Social Capital: Connections between and within social networks improve the capacity of individuals and groups to prepare for and withstand impacts of climate change;
- Institutions: Well-developed social institutions are believed to have greater adaptive capacity than those with less effective institutions; and
- Equity: Some research shows that adaptive capacity is greater where there are government institutions and arrangements in place that allow for equitable access to resources.

Source: ICLEI – Local Governments for Sustainability (2010)

Which regions are vulnerable?

This chapter considers northern, coastal, and remote regions that are "vulnerable". It is important to note that these characteristics are not mutually exclusive. A region could be both coastal and remote, with intersecting and amplifying vulnerabilities. Canada has the longest coastline in the world - 243,042 km, on three oceans (Statistics Canada, 2012), much of it in the north.

Vulnerability is a function of a high sensitivity (i.e., degree to which a system could be affected adversely or beneficially by climate change) and a low adaptive capacity (the ability of a system to adjust to climate change). In practice, communities existing in these regions are not only subject to slow-onset climate events such as ocean acidification, rising water temperatures, or sea ice loss, among many others, but are more sensitive to these effects due to a variety of factors, for example:

- A historical and ongoing burden of colonialism, geographic remoteness, and disproportionate fiscal pressures;

- Sub-standard infrastructure, limited access to services, and a heavy reliance on climate-sensitive economic activities;

- A landscape highly sensitive to slight changes in temperature and precipitation;

- A shortened winter road season that can prevent critical shipments of necessary infrastructure, medical supplies, equipment, and fuel, while also raising costs; and

- Economic, health, and cultural, and livelihood impacts, resulting from the shift from localized subsistence economies to centralized cash economies and a decline in access to traditional food and medicine.

As a result, the adaptive capacity of these regions is often significantly lower than that of other regions. Given the potential socio-economic, spiritual, mental, social, and cultural impacts, as well as the concentration of communities and economic activities along Canada's coasts and northern regions, there is an urgent need to identify and implement adaptation measures that will improve community and ecosystem resilience.

Box 7: Pangnirtung, Nunavut

In Pangnirtung, Nunavut, the community declared a state of emergency in June 2008 when the town's only bridge collapsed due to rapid permafrost thawing and erosion from floodwater.

The bridge connected the two halves of Pangnirtung. Its collapse bisected the community, with only one half having access to fresh water delivery or sewage removal. Due to heavy winds that delayed the arrival of engineers and geotechnical experts, the two parts of the community were separated for a significant period of time.

Source: Working Group on Adaptation and Climate Resilience (2016)

Considerations for Measuring Progress

Using the conceptualization of vulnerability described in the previous section, the Expert Panel developed indicators to measure the resilience of vulnerable regions to slow-onset climate change impacts. Indicators were intended to be positive-facing (showing a positive or increasing trend), demonstrating that an increase in resilience will decrease that region's vulnerability. The following other factors were also considered as indicators were developed:

- Northern, remote, and coastal regions are not mutually exclusive, meaning that individual communities could be considered as a northern, remote, and coastal community. One example of such a community is Tuktoyaktuk, which is located on the shores of the Arctic Ocean in the Northwest Territories. It is a majority-Indigenous community of fewer than 1,000 people that has experienced coastal erosion rates nearing 2 meters per year (Working Group on Adaptation and Climate Resilience, 2016).

- These communities are often small and may lack capacity to participate in measurement exercises, especially those not directly related to their planning, decision-making, and adaptation needs. As a result, community administrative offices and members will have to contribute data so awareness of what is being measured and how it will benefit them will be essential for sustained participation in measurement efforts (as well as ensuring that the indicator is meaningful to them). Further, it is difficult to quantify some of the attributes of capacity, requiring novel approaches to create a sustained measurement system.

- Northern, remote, and coastal regions are geographically spread across Canada resulting in data that may be collected and aggregated by different jurisdictions. This means that consistent data collection and interpretation is a challenge. More specifically, weather collection is a challenge, and federal weather and climate networks could consider prioritizing the collection and development of accessible, real-time data for vulnerable regions to address this gap.

Box 8: Old Crow, Yukon

In June 2007, permafrost thaw resulted in the draining of more than 80% of Zelma Lake, part of an ecologically significant network of lakes in northern Yukon called the Old Crow Flats. The Old Crow Flats are closely linked to the cultural identity of the Vuntut Gwitchin.

"I was raised in Crow Flats [...]. For years my Mother monitored that area and noticed the permafrost thawing. In 2007 the lake broke through and [...] with it went our fish, the caribou changed their migratory route, and the ducks and birds disappeared. The whole of Old Crow Flats is changing very fast due to climate change. The traditional and cultural knowledge that is paramount for the survival of our future generations is under duress; people choose not to go to these traditional lands much anymore. It's affecting our whole way of life as Gwitchin—our cultural activities, our health and well-being."
Norma Kassi, Director of Indigenous Collaboration with the Arctic Institute of Community-Based Research.

Source: Working Group on Adaptation and Climate Resilience (2016)

- Northern, remote, and coastal communities might not have access to reliable local weather data if they do not run their own monitoring stations. Additionally, instrument measurements of climate and weather patterns may not exist, and communities may use Indigenous or local science to predict weather and observe patterns. As climate impacts continue to alter their landscapes, these sources of knowledge may have difficulty in keeping up with the changes. Furthermore, communities in northern, remote, and coastal regions may not have access to climate impact models, such as CLIVE (CoastaL Impacts Visualization Environment), a leading-edge climate change impacts visualization tool at the University of Prince Edward Island, to understand how slow-onset events may affect their region.

- One approach that has been increasingly supported is "community-based monitoring". A network of community-based monitors of climate change impacts would be responsible for the documentation and dissemination of observations on climate trends and impacts using Indigenous, local, and scientific ways of knowing. Other promising models to draw on include the Local Environmental Observer Network, Indigenous Guardians, and other Environmental Guardians / Watchmen model (see the indicator templates in Appendix III for more information). The Indigenous Guardians program, which received $25 million over five years in the federal government's Budget 2017, supports Indigenous land management and oversight. These are important steps in supporting the ability of Indigenous Peoples to self-determine in their data collection, decision-making, and monitoring for impacts.

Finally, it is important to consider the issue of data equity in the context of vulnerable regions. Given their geographical dispersion and relatively low population, northern, remote, and coastal regions are often forgotten in the calculations of "data availability" (i.e., whether data availability is sufficient and of high enough quality) and "cost effectiveness" (i.e., whether the benefits of addressing data availability gaps exceed the costs). We hope that by understanding the importance of these regions, we can prioritize their resilience.

Moving forward, efforts to increase the resilience in northern, remote, and coastal regions must acknowledge the social determinants of climate adaptation. This means that a region's ability to adapt to slow-onset events depends heavily on factors potentially outside the scope of traditional "climate change" related issues, such as the adequacy of basic services, including safe water supply and shelter, as well as access to country foods, cultural expressions (e.g., cultural locations, practices, spiritual ceremonies), and language. Programs, policies, and funding must be targeted directly towards community to self-determine the required activities to support their resilience (more specifically, support for climate services, including for weather and climate data networks, which can provide real-time data to communities and sectors in vulnerable regions).

Recommendations

Key considerations which led to the recommendations in this chapter include the appropriateness of measurements, inclusion of Indigenous perspectives and holistic approaches, potential for demonstrating progress, and the issue of equity within the Expert Panel's analysis (for example, addressing head-on the issues of data availability and cost effectiveness, which are often cited as reasons to not address vulnerable regions). These indicators were developed in line with four major objectives and are organized to evaluate understanding exposure, reducing sensitivity, increasing adaptive capacity, and improving regional collaboration.

Objective 1: Increase northern, remote, and coastal regions' understanding of slow-onset events

Identifying risks is the first step in community adaptation to climate change, as most risks from slow-onset climate change impacts must be known to be addressed. Unfortunately, communities in northern, remote, and coastal regions may not have access to climate models to understand how these events will impact their region. As a result, it is essential that planning mechanisms like risk assessments or adaptation plans are supported to help mitigate or even avoid impacts that might otherwise have had a serious negative impact on northern, remote, and coastal communities (such as coastal erosion).

Adaptation plans take this one step further by identifying actions that can be taken to address risks and avoid or mitigate impacts. To inform this, communities must have access to local weather and climate data to understand changes in weather and climate patterns. It is important, however, that planning mechanisms are not viewed as an end, rather a means to an end that is supported when there are adequate implementation mechanisms, including access to funding. This will be furthered addressed in Chapter 5: Building Climate Resilience through Infrastructure.

10. Percentage of communities in northern, remote, and coastal areas with community-based, specialized (e.g., coastal erosion, permafrost thaw, etc.) environmental monitoring programs that incorporate climate/weather observations

This indicator measures the percent of northern, remote, and coastal communities that have a community-based monitoring program for the documentation and dissemination of observations on climate trends and impacts. Measuring the percent of northern, remote, and coastal communities that have a community-monitoring program would help measure incorporation of Indigenous, local, and scientific forms of knowledge to inform community and regional decision making. It also raises awareness and contributes valuable information for community adaptation initiatives in the face of slow-onset climate events, as well as empowers communities to take control of their data, enabling them to report their observations to decision-makers.

11. Percentage of population with access to local information on climate change, weather patterns, and associated impacts to regions and sectors in northern, remote, and coastal regions

This indicator assesses the access of communities in northern, remote, and coastal regions to essential information to measure adaptation to changing climate and weather patterns. Northern, remote, and coastal communities might not have access to reliable local weather data if they do not run their own monitoring stations. Additionally, instrument measurements of climate and weather patterns may not exist, and communities may use Indigenous or local science to predict weather and observe patterns. As climate impacts continue to alter their landscapes, these sources of knowledge may have difficulty in keeping up with the changes.

12. Percentage of communities and regions in northern, remote, and coastal areas with planning mechanisms that incorporate or consider climate risk and opportunities

This indicator documents progress in the development of planning mechanisms, such as risk assessments or adaptation plans, by communities and regions in northern, remote, and coastal areas. Planning mechanisms are an important first step to inform future adaptation action, which must be followed by implementation measures.

Planning mechanisms like risk assessments or adaptation plans can help mitigate or even avoid impacts that might otherwise have had a serious negative impact on northern, remote, and coastal communities, for example coastal erosion. Identifying risks is the first step in community adaptation to climate change, as most risks from climate change impacts must be known to be addressed. Adaptation plans take this one step further by identifying actions that can be taken to address risks and avoid or mitigate impacts. It is important, however, that planning mechanisms are not viewed as an end, rather a means to an end that is supported when there are adequate implementation mechanisms, including access to funding.

Objective 2: Reduce the sensitivity of northern, remote, and coastal regions areas to slow-onset events

Communities in northern, remote, and coastal regions rely heavily on the land for their cultural, spiritual, and economic well-being. Many philosophical thinkers and knowledge keepers have shared the deep connection that Indigenous Peoples have to "our mother" the Earth, the four directions, the many elements and spiritual teachings about our living world, including our Grandmother Moon and Grandfather Sun. As the prevalence of slow-onset events continues to increase, this connection is threatened. Of note, Indigenous communities' traditions, cultures, and languages may change or be lost due to climate change impacts (e.g. words for certain animals that have migrated away lost). For many, the resurgence of cultural programs including language is an important way for Indigenous Peoples to build resilience in the face of these oncoming threats. Cumulatively, this means that members in their community are more "sensitive" to the impacts of slow-onset events, such as thawing permafrost, rising sea level, and species migration. To reduce a community's sensitivity to slow-onset events, the Expert Panel proposed looking at the safety training, response times, access to land, and funds directed to protecting cultural assets, all components of building resilience.

13. Number of key members of community (e.g., police, firefighters, water technicians, harvesters) with safety training and equipment to adapt to changing conditions

As slow-onset events continue to increase, the need for safety training and equipment to track, understand, and adapt to these conditions is essential. This indicator measures the number of key community members, such as harvesters who must go on the land to harvest traditional foods and medicines, who have safety training and equipment. An increase in the equipment and training of these members may lessen their vulnerability to the change conditions and thus increase their resilience, while enabling them to conduct their traditional activities.

14. Maximum response times in northern, remote, and coastal regions related to search & rescue and emergency response programming

This indicator documents the response times for emergency and search and rescue teams. This relates to building resilience in northern, remote, and coastal regions because residents in these regions are in areas of higher risk from climate change impacts and may engage in higher risk activities, e.g. harvesting foods. By measuring maximum response times in northern, remote, and coastal regions and Indigenous communities, we can document improvements (or declines) in emergency response times. Climate change impacts will affect the weather, water, and land which many residents of northern, remote, and coastal regions rely upon, indicating that risk of accidents and emergencies will rise.

15. Percentage of people in northern, remote, and coastal communities whose access to the land, including country foods and traditional ways of life, is impacted by slow-onset events

Indigenous Peoples' access to the land, including country foods and traditional ways of life, is central to their identity. As slow-onset events continue to threaten their access to the land, culture, spirituality, knowledge, and identity are at risk of being lost or substantially changed. This indicator intends to document the percentage of community members' traditional way of life that is impacted by slow-onset events.

16. **Number of funded initiatives directed at protecting cultural assets (e.g., archaeological/historical sites, spiritual sites, traditional foods/plants/medicines) located in vulnerable regions from climate risks**

This indicator documents the protection of cultural assets of northern, remote, and coastal regions/communities that are under threat from climate change impacts. It is important to build resilience in this area because, as vulnerability is defined, these assets may be permanently lost due to climate change.

Cultural assets are particularly vulnerable to impacts of climate change because they do not regenerate. These assets may be in especially vulnerable regions, along coastlines or in northern or remote locations that are difficult to protect.

Box 9: Lennox Island, Prince Edward Island (PEI)

Located on PEI's north shore, the Lennox Island First Nation is experiencing both rapid population growth and severe climate change impacts. Sea-level rise and erosion are reducing the size of Lennox Island and increasingly severe storm surges threaten access between the island and mainland PEI. Two homes on the island are already in need of assistance, with the choices being to relocate the homes, which will have significant cultural impacts, or to reinforce the shoreline. While both options will be expensive, the community remains resolute to their homeland: "We're not going anywhere. We're resilient. We're going to do what we can to protect our little island," said Chief Matilda Ramjattan (Kassam, 2017).

Source: Working Group on Adaptation and Climate Resilience (2016)

Objective 3: Increase the adaptive capacity of northern, remote, and coastal regions by providing the human, technical and financial resources to self-determine their response to slow-onset events

Human, technical, and financial resources are required to respond meaningfully to slow-onset events. This means that adaptation plans are funded, experienced and/or trained locals remain in the community, and that climate and weather data is controlled by the community. In particular, the localization of talent / expertise will enable communities to reduce the heavy cost of planning mechanisms and ensure that culturally grounded and relevant adaptation plans are created. It will also facilitate ongoing support to implement the plan. To start, the Expert Panel specifically looked at the amount of human and financial capacity flowing into these communities. Importantly, the indicator relating to financial capacity can be found in Chapter 5: Building Climate Resilience through Infrastructure (Indicator 38).

17. **Percentage of northern, remote, and coastal communities with experienced and/or trained locals (including Elders with Indigenous Knowledge Systems) that are designing and implementing adaptation actions in their regions and/or communities**

This indicator measures the percentage of northern, remote, and coastal communities with locals experienced and/or trained in designing and implementing adaptation actions. Having experienced and/or trained locals will empower communities to design and implement the planning mechanisms outlined in abovementioned indicators.

Objective 4: Improve regional collaboration between governments, communities, Indigenous Peoples, the private sector, and other relevant stakeholders (including agreements like MOUs and Data Sharing, which facilitate data access)

Better outcomes can be achieved by taking a multi-stakeholder approach to regional adaptation planning. A comprehensive and inclusive process would include all stakeholders and right-holders who want to participate, e.g. non-governmental organization (NGOs), governments, municipalities, Indigenous communities, Tribal Councils, and more. This will avoid future disagreements and build positive relationships. As well, knowledge will be shared across sectors which might not otherwise have been accessible. This will lead to more effective and comprehensive adaptation plans, with all stakeholders in the region on board and supporting. This support will also be useful when applying for funding to implement regional adaptation plans.

18. Number of adaptation initiatives and/or formal agreements (MOUs, etc.) that include a multi-stakeholder approach (governments, communities, Indigenous Peoples, private sector, and others) for regional planning

This indicator documents regional adaptation planning agreements, which take a multi-stakeholder approach. This is important for resilience, because it facilitates cross-sectoral knowledge-sharing and mutually-beneficial partnerships.

Chapter 4: Reducing Climate-Related Hazards and Disaster Risks

Disaster risk reduction in the context of this chapter focuses primarily on non-structural measures to reduce impacts from rapid-onset (acute) climate-related events, aligned to the four components of emergency management: prevention, preparedness, response and recovery. Each component is interrelated with the goal of protecting lives, property, the environment and the economy.

This chapter also considers that the more slow-onset (chronic) events such as drought conditions, changes to long term water supply and ecosystem degradation can lead to a rapid-onset (acute) event and should be considered not only at a more regional or watershed scale but also as an underlying factor that can aggravate and amplify climate hazard impacts. This link was discussed in more detail in in Chapter 3: Supporting Particularly Vulnerable Regions.

Many of the indicators recommended in this chapter could be disaggregated by type of climate-related disaster and by region to show response and recovery efforts specific to vulnerable regions. Box 10 provides several types of both rapid-onset (acute) and slow-onset (chronic) climate-related disasters.

Box 10: Climate-related disasters

Potentially damaging physical event or phenomenon that may cause loss of life, injury, property damage, social and economic interruption or environmental degradation due to climate hazards such as:

Rapid-Onset
- Flood
- Wildfire
- Hail
- Extreme heat & cold
- Winter ice storms
- Extreme winds

Slow-Onset
- Sea level rise
- Drought
- Thinning ice
- Permafrost thaw
- Shifting seasons
- Invasive species & disease
- Ecosystem degradation

The Pan-Canadian Framework on Clean Growth and Climate Change identified three short term priorities for reducing climate-related hazards and disaster risk: investing in infrastructure to reduce disaster risks; advancing efforts to protect against floods; and supporting adaptation in Indigenous communities. In regard to infrastructure, this chapter focuses on identifying climate-hazard areas, influencing land use planning, and monitoring exposure within these areas, while Chapter 5: Building Climate Resilience through Infrastructure focuses specifically on infrastructure design for future climate conditions as well as exposure and reliability of critical infrastructure and basic services.

This chapter acknowledges that floods are one of the costliest climate change impacts Canada experiences. However, as not all communities across Canada identify floods as their highest climate risk, the indicators selected in this chapter allow for application in many contexts based on locally identified climate-related hazards.

This chapter also considers the ten high-risk vulnerable populations as identified by the Canadian Red Cross (Canadian Red Cross Society, 2007; see Box 4), who may be located within most communities. While this list includes Indigenous Peoples, more information pertaining specifically to northern, coastal, and remote regions can be found in Chapter 3: Supporting Particularly Vulnerable Regions.

It is important to note that by aligning indicators in this chapter with the pillars under the Pan-Canadian Framework on Clean Growth and Climate Change, chronic impacts to ecosystems have not been sufficiently captured, but must also be planned for and monitored as discussed in Chapter 3: Supporting Particularly Vulnerable Regions but should extend beyond just northern, coastal and remote regions.

Context

Climate-related disasters (see Box 10) in Canada are likely to increase in frequency and/or intensity as climate change continues. For example, the wildfire season has lengthened due to changes in temperature and precipitation patterns, the severity of wildland fires is increasing due to drought- and pest-stressed forests and range lands, and the extent of storm surge flooding is increasing due to sea level rise (Warren and Lemmen, 2014).

As Canada's exposure to climate-related disasters increases due to continued climate change, the need to plan for, respond to, and recover from these events effectively and efficiently becomes more pressing. In the context of climate-related hazards and disaster risks, a critical opportunity to integrate resilience is following an event because of significant investment in recovery efforts and a heightened awareness of climate-hazards and local risks. However, the need to recover quickly and get systems and people back in functioning order often comes in direct conflict with the incremental nature of resilience building after an event. Recovery plans must be in place prior to a disaster event and should include widespread stakeholder engagement including Indigenous Peoples (rights holders) and vulnerable populations to successfully and efficiently 'build back better', which may mean not building back in that location at all.

Note that Canada is a signatory to the Sendai Framework which lays out international guidance to Disaster Risk Reduction under the auspices of the United Nations International Strategy for Disaster Reduction (UNISDR). That framework established four priorities for action: understanding disaster risk, strengthening disaster risk governance, investing in disaster risk reduction for resilience and enhancing disaster preparedness for effective response, including for Building Back Better. These priorities are implicitly included in our approach below.

It is well documented that vulnerable populations are more negatively impacted by climate change, as discussed in Chapter 2: Protecting and Improving Human Health and Well-Being. Vulnerable populations require unique support during response to a disaster, such as methods for warning or communication systems, including trusted messengers, considerations for facilitating evacuation, or culturally appropriate shelters and food if displaced from homes. They would also have less financial capability to recover after an event or even afford housing less exposed to climate-related hazards. Vulnerable populations or their representatives must be included in all phases of emergency management, be able to self-determine appropriate measures in alignment with the local context and be involved and/or influence decision-making within Emergency Management Organizations (Canadian Red Cross Society, 2007).

As the type, frequency, and severity of a climate-related event will vary across Canada, it will be important for each community and region to identify their own climate-hazard priorities, which will require having local capacity to do so. The prevention of further exposure and reduction of existing exposure to a location-specific climate hazard, such as riverine or shoreline flooding, is a first step for all communities and regions, as doing so reduces the impact of that event and the extent of response and recovery efforts required following that event. It is important to recognize that by leaving existing development in place and building protection measures around it, the climate-related risk is only reduced but not eliminated.

Increasing development behind protection measures but still within climate-related hazard areas increases the long-term risk for events exceeding the design capacity of the protection measures.

Considerations for Measuring Progress

Many types of climate-related hazards have always occurred. However, the increasing frequency and severity of these events, as well as the increase in population, development, and human reliance on technology, has exacerbated existing risks and constrained adaptive capacity. Exposure to climate-related hazards varies by community and region, and the local and cultural context of each community will need to be considered when planning for, responding to, and recovering from climate-related disasters. Exposure cannot be eliminated; however, efforts can be made by individuals, businesses, communities, and governments to reduce exposure. Chapter 3: Supporting Particularly Vulnerable Regions talks to reducing sensitivity and increasing adaptive capacity, which communities must also consider in connection with exposure.

To plan for, respond to, and recover from climate-related disasters, communities require climate change analysis. As many communities do not have the technical or financial resources to develop and analyze this data, support from provincial, territorial, and federal governments, such as through the provision of climate services and the development of planning guidance, will be required. Supporting capacity building of communities, particularly to utilize Geographic Information Systems (GIS) or implement community-based monitoring programs, will also be critical to measure progress on many of the indicators.

Other stakeholders, such as Indigenous Peoples, the private sector and civil society, as well as vulnerable populations, have a key role to play in reducing disaster risks. Funding opportunities for adaptation action should consider the role of these players in disaster reduction and adaptation programming.

Recommendations

In selecting indicators to reduce climate-related hazards and disaster risk, it is understood that each region will be exposed to different climate-related hazards and will have various levels of exposure and vulnerabilities. The common denominator for all regions is that critical infrastructure, basic services and vulnerable populations need to be the priority in making strides in reducing disaster risk. Indicators for the exposure and disruption of critical infrastructure and basic services are in Chapter 5: Building Climate Resilience through Infrastructure. Preventing and reducing exposure is the best strategy for reducing disaster risk, recognizing there are limitations of how to reduce the exposure in some locations. The following objectives and indicators were identified for reducing climate-related hazards and disaster risks, and more detailed information about each indicator is provided in the Appendix III.

Objective 1: Prevent and reduce exposure to hazards exacerbated by climate change while recognizing limitations of existing built environment

The value of investing in prevention far outweighs relying on preparedness, response and recovery when considering not only the cost of damages, but the impact to health and well-being of citizens as well as the individuals involved in response and recovery efforts. Every dollar spent in disaster risk reduction saves $6 in emergency response (Multihazard Mitigation Council, 2017). There are opportunities to permanently remove properties from floodplains through mitigation measures, reduce vulnerability to wind and ice, improve urban drainage systems to address urban flooding from extreme rainfall, and prevent building in hazard zones through appropriate planning restrictions.

It is also important to consider instances where action in support of other priorities may counteract efforts to enhance climate resilience. For instance, cities may identify densification as a priority to support climate change mitigation, as densification can reduce GHG emissions associated with transportation. However, climate resilience may decrease in cases where densification results in an increased number of residents living near rivers, lakes, forests or other climate-related hazard areas, potentially requiring greater emergency management measures and increasing the risk of damage because of climate-related disaster events.

19. Percentage or number of communities with development and re-development 'build back better' control policies, bylaws and regulatory tools for climate-related hazards that are culturally appropriate and include Indigenous Knowledge Systems where appropriate

While there are many communities built in areas of climate hazard, one of the easiest ways to reduce future risk is to have policies at the provincial and municipal levels that direct new development away from hazard areas or direct the form that it will take to make it more climate hazard resilient. This may include 'build back better' policies to flood proof or fireproof structures for example, where deemed necessary to rebuild in the hazard area.

Further, these policies and plans can be implemented immediately following a disaster event and tough decisions would have already been agreed upon and not subject to conflicts of opinions during a disaster. Note again that such 'build back better' control policies and tools should include consideration of strategic retreat – the option of not building back in harm's way at all.

20. Percentage or number of communities with climate-related hazard mapping incorporating climate change utilizing scientific information and, where appropriate, Indigenous Knowledge Systems

Some hazard mapping already exists, but in most cases, does not consider the spatial extent and extremes that will be further influenced by climate change. Climate services to support hazard mapping will need to be available and accessible for all communities. Guidance will be needed on what climate extremes to plan for to facilitate consistent design and reporting.

21. Number of high-risk vulnerable populations in locally identified high-risk climate hazard areas (not accounting for defenses)

Vulnerable populations are typically the most heavily impacted by disasters because of additional or specific requirements to facilitate emergency response and have less capacity to recovery or adapt to changing conditions. Therefore, it should be a priority to prevent or reduce the amount of vulnerable populations within known climate-hazard areas (for example, in some specific cases, relocation may be needed).

22. Number of properties (residential and businesses) in climate adjusted river and shoreline flood hazard areas (not accounting for defenses)

Due to varying policies in Canada defining an acceptable risk tolerance for development as well as for development in place prior to the availability of river flood hazard mapping, many communities in Canada already contain development within floodplains. However, with the potential for changing precipitation regimes and rising sea level to increase the severity or frequency of flooding, or for flooding to occur at various times, the extent of development within a floodplain may increase (as the extent of floodplains themselves may increase, into areas not previously identified as floodplains).

Some areas may require a managed retreat out of the floodplain. However, there are limitations to uprooting existing development, and thus, protection of existing development may also be warranted (focusing on critical infrastructure and vulnerable populations). Protection from overland flow in these areas reduces the risk of flooding but does not eliminate the risk due to elevated groundwater, potential for sewer backup, and the dependence on operational measures such as closing outfall gates, operating upstream storage facilities or evacuation during an event. Although overland flood protection may be put in place, other risks still exist and the push for densification of development in these areas may increase exposure in the long run and should be avoided.

23. Number of watershed or regional-scale water management plans incorporating future water supply due to climate change

Parameters that vary by region, such as increasing air and water temperatures, longer growing seasons, wide spread glacier melt and a decline in water quantity and quality, drive the importance of managing future water supply and demand at a regional and watershed scale.

Box 11: Conservation Authorities in Ontario

Conservation Authorities were established as local watershed based natural resource management agencies by Ontario and municipal governments in response to significant soil erosion and flooding as a result of a variety of land management practices, such as development in floodplains and deforestation.

The Conservation Authorities Act of 1946 gave Conservation Authorities the power to study the watershed, determine a scheme to conserve, restore, and/or develop the watershed's natural resources, and to control waters to prevent floods or pollution. The Conservation Authorities Act requires Conservation Authorities to regulate and prohibit development in hazard areas – including land in – or adjacent to – watercourses or river valleys, Great Lakes, and large inland lakes shorelines, steep slopes and wetlands in order to protect people and control flooding and erosion.

Since 1946, 36 Conservation Authorities have been established, largely in the developed areas of Ontario, where approximately 90 percent of the province's population lives.

Conservation Authorities also undertake activities that help to prevent or manage flooding, such as modelling and monitoring streamflow, rainfall and snowpack, issuing flood and drought warnings as required, and providing planning support and advice to municipalities to manage the watershed to reduce runoff and potential flood effects.

Ontario's Conservation Authorities model removes the responsibility for each individual municipality or community and places that responsibility with a Conservation Authority in order to ensure consistent approaches to managing the province's watershed. This model continues to be beneficial to Ontario in the face of climate change impacts, and provides information and practices that can benefit the work of Canada's provinces, territories, and municipalities to manage the implications of climate change.

Objective 2: Increase preparedness for emergency response to hazards exacerbated by climate change involving high-risk vulnerable population representatives

Many communities in Canada are already experiencing an increase in climate-related disaster events, which will only increase in frequency and severity with a changing climate. The time and cost to reduce exposure and increase systems capacity is too large to eliminate the very immediate need to respond to these events and so progress on preparedness for disaster events is warranted.

Indigenous Peoples (rights holders) and vulnerable populations need to be involved in all aspects of preparedness planning, response and recovery for their communities, as well as decision-making and priority setting, since they have less capacity to adapt and have unique needs that must be considered in all phases.

24. Percentage or number of communities that have developed or updated emergency response plans that consider future climate-related hazard extremes

Specific components of what should be included in emergency response plans may vary by region and hazard type, and local conditions and capacity to respond must be considered in development on response plans, such as for northern regions. Many communities may already have emergency response plans, but they need to be reassessed to consider the hazard extremes affected by climate change. Having data and up-to-date hazard mapping will aid in more rapid response to most critical areas.

25. Percentage or number of emergency management organizations that have representatives of local and/or regional high-risk vulnerable populations that participate in prioritization and decision-making

"The people and/or the programs are designed to help should be the people involved in designing the process." (Lindsay and Hall, 2006). Analysis by the Canadian Red Cross for Public Safety Canada determined that significant gaps exist in meeting the needs of high-risk populations where resources as well as networking and bridge-building between emergency management and voluntary organizations serving high-risk populations is needed at all levels (Canadian Red Cross Society, 2017).

26. Number of hours of climate-related disaster response training and exercises

The type of training will vary based on locally identified climate-related hazard risks and the groups or organizations that would be involved in emergency response. Training should be done on a regular and ongoing basis, involving multiple stakeholders.

27. Percentage or number of culturally and locally relevant emergency response warning systems focusing on high-risk vulnerable populations

Local warning systems to facilitate emergency response actions need to consider communication tactics at a local context specifically for high-risk vulnerable populations. These groups may also need additional support to carry out an emergency response action, such as evacuation, and should be considered in the response warning systems.

Objective 3: Improve the efficiency and equity of emergency response to future climate-related hazard events

The speed of emergency response is directly correlated to the impact of a disaster on the safety, health and well-being of citizens and in some cases the amount of damages. Response to a climate-related disaster varies based on the type of disaster, the region where it occurs and the local vulnerabilities. Although response times may vary given the local or regional context, appropriate systems need to be in place to respond efficiently wherever the need.

28. Average speed of emergency response to an event focused on high-risk vulnerable populations

The combination of higher risks and smaller communities, particularly in vulnerable regions, means that the need to respond may become more urgent but the ability to maintain emergency services locally is cost prohibitive. If response times can be reduced to support vulnerable populations then steps have been made to identify vulnerable populations and improve the methods of providing that support.

29. Number of people directly affected by a climate-related disaster

Although both direct and indirect impacts (UNISDR, 2017a) are important to manage for climate-related disasters, direct impacts are more clearly measurable. The intent of this indicator is to see a reduction in the number of people directly impacted as efforts to reduce exposure advance. This number will likely increase for many years as the frequency and severity of climate-related disasters increases across the country, but it would be a long-term indicator of progress of addressing infrastructure improvements and hazard mitigation.

Objective 4: Improve efficiency and resilience during recovery following climate-related hazard events

Successful recovery from a climate-related disaster event often requires financial assistance provided in a timely and fulsome way. As experienced in Hurricane Katrina, lasting social cohesion often relies upon such metrics. The longer it takes for funds to flow, the less attractive community rebuilding can be. This is why multinational resilience funds have been established in the Caribbean, Africa and the South Pacific. The Caribbean Catastrophic Risk Insurance Facility (CCRIF), for example, is explicitly designed to quickly deploy funds to communities and citizens to ensure social cohesion post-disaster. The CCRIF has a policy payment standard of only 14 days for this reason.

Resilience funds sourced from the private sector typically flow much faster and are designed for more fulsome compensation than those from government-backed disaster relief programs. The metrics in this section, therefore, can also be used to determine the robustness of the private insurance market for a particular hazard. Currently, in Canada, the private insurance market for wildfire is very well developed as fire insurance has been a requirement for most home mortgages for decades. Conversely, the overland flood insurance market is poorly developed. These metrics should demonstrate resilience trends for these and other hazards.

It is anticipated that the total cost of damages (insurable and non-insurable damages) will likely continue to increase until 'build back better' policies and plans can improve resilience of existing development. It is critical that future financial assistance instruments from either public or private sources be designed to be as timely and as comprehensive as possible to facilitate recovery.

30. Number of days for citizens to receive financial assistance (cash-in-hand) from time of application

The speed in which citizens receive financial assistance, from public or private sectors, is a key metric associated with retention of community confidence needed to restore a level of normalcy post-disaster. Speed of recovery is also essential to reduce recovery costs such as for basement flooding and the need to prevent mold development in basement material, which can impact human health and result in higher recovery costs.

31. Percentage of total financial losses restored, making citizens whole

Given that Canadian citizens often have much of their financial wealth invested in their real property, this indicator is a direct measure of resilience. This indicator is also positively correlated with the maturity of the private insurance market as insurance funds are designed to 'make people financially whole' whereas funds from public sources are only designed for partial compensation. If this metric is positive over time, it indicates that resiliency is increasing as partial compensation public risk pools give way to full compensation private risk pools. Typically, for events that are well-insured such as wildfire in Canada, citizens see full compensation for their claims. For events that are not well insured, or for which insurance products are poorly articulated, such as overland flooding in Canada, compensation percentages will be lower. Note that this metric may be disaggregated to measure improvements in private insurance coverage alone.

Chapter 5: Building Climate Resilience through Infrastructure

Climate-related infrastructure failures can threaten health and safety, interrupt essential services, disrupt economic activity, and generate costs for recovery and replacement.

Considering climate change in infrastructure planning and design, investing in traditional and natural infrastructure solutions and improving operation and maintenance practices can build community resilience, reduce disaster risks and save costs over the long term. Measuring progress on building resilience through infrastructure is challenging due to data constraints, infrastructure system interdependencies, attribution issues and different community contexts, among other things.

This chapter provides advice on how to measure the resilience of Canada's traditional and natural, new and existing, and critical and non-critical infrastructure, as well as the interdependencies of infrastructure systems. It focuses on efforts to increase the resilience of infrastructure components and systems through planning, design, investment, operation and maintenance.

Context

Infrastructure plays a critical role in social, economic, and ecological well-being. Infrastructure across Canada provides essential services, protects people, assets, and livelihoods, and connects systems to enable the flow of goods, services, and information across multiple sectors, and within and between communities.

Canada is already experiencing the impacts of climate change, and the impacts of climate change on infrastructure are wide-ranging and diverse across the country. For example, rising sea levels, storm surges, permafrost degradation, extreme rainfall and extreme heat can cause damage to infrastructure, including buildings, critical infrastructure and critical facilities, and can disrupt the delivery of essential community services (e.g., health care, utilities, water and waste-water, telecommunications, emergency services, transportation routes, power). Extreme weather can also damage or disrupt important trade and transportation infrastructure, including roads, rail lines, ports, and airport runways. As Canadian infrastructure ages, it will become increasingly vulnerable to both rapid and slow onset climate-related events.

Existing vulnerabilities in infrastructure and in the social and economic systems that it supports are increasingly exposed because of extreme weather. This is particularly prevalent for Indigenous Peoples, for whom infrastructure integrity is already a concern, and in the North, which is experiencing a disproportionately accelerated rate of climate warming. Canada's goal should therefore be to not only maintain current service levels, but to improve them, ensuring that all Canadians have access to the critical infrastructure and essential services they need. Infrastructure discrepancies across communities should be factored into infrastructure planning and investment, as well as the indicators used to measure progress on climate resilience.

We must adapt and build resilience to ensure that future and existing infrastructure, as well as the communities that rely on it, are adequately prepared for future climate conditions. Therefore, "Building

Climate Resilience through Infrastructure" is a key area of action of the adaptation and climate resilience pillar of the Pan-Canadian Framework on Clean Growth and Climate Change.

In this chapter, the Expert Panel focused on key phases of infrastructure decision-making such as planning, design, investment and performance. The objectives and indicators detailed below seek to incorporate climate resilience into each phase and measure Canada's progress in building resilience through infrastructure into the future.

Considerations for Measuring Progress

Measuring progress on building resilience through infrastructure is challenging for several reasons.

While indicators related to integrating climate resilience into the policies and processes that dictate infrastructure planning, design and investment are available, it is more challenging to measure whether these policies and processes translate to actual climate-resilient outcomes on the ground. For instance, determining whether a building, structure, kilometre of road or infrastructure system is truly resilient to climate impacts is difficult. Codes and standards that set out specific climate resilient design parameters can help, but often these are voluntary and their uptake for specific infrastructure components and systems is hard to track. As infrastructure ages, it must also be adequately maintained to ensure it continues to meet climate-resilient standards; maintenance patterns are also difficult to track. Existing infrastructure is even more challenging to address, as most existing infrastructure was not built for future climate conditions and retrofit opportunities can be limited and costly.

To overcome these barriers, indicators such as infrastructure failure, avoided costs and service disruption may be used to test climate resilience. However, it may be the case that costs were avoided, or levels of service were maintained because the 1-in-500-year flood never occurred, not because the infrastructure system was built and maintained to withstand the event. Attribution issues can also arise in the contexts of adaptation and resilience investments. It is difficult to uniquely identify and attribute the benefits of climate change adaptation action from other elements of infrastructure planning, investment, design and decision-making.

Measuring the resilience of infrastructure also requires consideration of the overall systems and context in which that infrastructure functions. Most infrastructure systems are dependent on other systems for service delivery (e.g., energy, telecommunications, storm water management) and function within larger systems. The complex interdependencies within infrastructure networks means we need to look beyond the principal sector (e.g., transportation network) to other interdependent sectors (e.g., electricity, telecommunications) to fully understand whether climate resilience efforts are achieving success.

Differences in local climate impacts and approaches to climate resilience also present challenges in measuring progress and selecting indicators that are nationally applicable. For example, increasing hectares of forest may be an excellent indicator for flood-prone regions but may be counter-productive in fire-prone regions or not relevant for areas above the tree-line.

More work is needed to better include Indigenous Knowledge Systems into infrastructure planning and design. Culturally-grounded designs such as igloos and teepees are already inherently climate-resilient, but these may not be properly captured or considered in infrastructure codes and standards. Similarly, the relocation of Indigenous Peoples to marginal lands, such as floodplains, resulted in some Indigenous

Peoples being moved to areas now considered, in some policy and planning contexts, to be at higher risk of climate hazards. Meanwhile, such communities have a long history of successfully living on the land, moving with the seasons and managing risk accordingly. Working with Indigenous Peoples in infrastructure planning is necessary to ensure climate resilience efforts are based on Indigenous Knowledge Systems, including in analyses of climate risk and the valuation of natural and cultural assets.

Finally, data collection can also present problems for measurement. For example, the private sector plays a significant role in funding and building infrastructure, but it is challenging to collect data and measure action or progress in the private sector since many relevant strategies and initiatives may not be detailed in publicly-available documents or reported in a coordinated way.

To measure progress on building resilience through infrastructure, knowledge gaps must be filled. This can be done by collecting appropriate baseline information, such as whether a community's planning mechanisms incorporate climate resilience, a full inventory of all relevant existing codes and standards that affect built and natural infrastructure, and the identification of the relevant government departments that oversee procurement of infrastructure related services and assets. Requiring ongoing and localized assessment of climate risk to monitor infrastructure resilience over time is recommended, as is working with the private sector to better understand how its climate resilience efforts can be tracked. Defining infrastructure levels of service across several types of infrastructure can also help to establish a baseline for measuring differences from climate impacts and adaptation responses.

Recommendations

The Expert Panel identified four objectives for building climate resilience through infrastructure, which focus on key phases of infrastructure decision-making and seek to incorporate climate resilience into each phase. In order to identify indicators for each objective identified under the building climate resilience through infrastructure area of action of the Pan-Canadian Framework on Clean Growth and Climate Change, the Expert Panel focused on the most important "insertion points" for climate-resilience in infrastructure decision making – planning, design, investment, maintenance, operation – as well as the importance of natural infrastructure solutions.

Objective 1: Integrate climate resilience into policies, bylaws, plans and other planning mechanisms that direct development, affect safety, determine placement of infrastructure and consider interdependencies

This objective considers infrastructure planning, design and development. Where infrastructure is located or re-located (e.g., in floodplains, coastlines or other hazard zones) can impact its safety and longevity. How and where communities are built should consider the resilience of the infrastructure systems that support them. This objective also considers the codes and standards used to guide infrastructure construction and development and improve resilience in designs.

32. Percentage of communities (regional, municipal, Indigenous Peoples) with planning mechanisms that incorporate or consider climate resilience in community infrastructure development

This indicator measures the extent to which climate resilience has become a standard part of community planning processes that directly influence how infrastructure is located, designed and built (e.g., through official community plans, zoning bylaws and Indigenous planning mechanisms, among others). This indicator would apply to both new and existing infrastructure; therefore, it would also apply to the re-location and retrofitting of existing infrastructure. Community infrastructure planning was selected as the appropriate scale for measuring progress on infrastructure resilience as it encompasses both infrastructure systems as well as site-specific infrastructure projects.

33. Number of codes and standards reviewed, updated and developed across the full breadth of climate hazard types and asset types at risk, including Indigenous-specific building programs

This indicator tracks progress in reviewing, developing and updating national codes and standards that guide how infrastructure is designed and built. Note that some codes and standards may be more relevant for certain Indigenous Peoples (e.g., standards specifically for the North) and some codes and standards may not be relevant at all. Indigenous Peoples may prefer to self-determine what constitutes "climate-resilient" for some types of infrastructure in their communities and develop culturally-appropriate building programs in lieu of codes and standards.

34. Number of government procurement documents integrating climate resilience considerations into their requirements and specifications for infrastructure

This indicator could track the extent to which climate resilience is becoming a 'must have' in procuring infrastructure-related services and development. It would consider procurement at all levels of government (e.g., federal, provincial, regional, municipal). As many large infrastructure projects are publicly-funded, the scope of this indicator could capture a meaningful proportion of infrastructure projects.

35. Number of critical infrastructure in locally identified high-risk climate hazard areas

This indicator will seek to measure and monitor the number of structures and buildings deemed to be critical infrastructure that are in high risk climate hazard areas (e.g., flooding, wildfire, permafrost thaw, etc.). If the number of structures and buildings can be reduced, it will indicate that communities have stopped building new infrastructure in high risk areas, moved critical infrastructure out of a high-risk area, or taken steps to mitigate the climate risk for that area.

Objective 2: Integrate climate resilience into infrastructure investments

This objective considers how governments choose to allocate infrastructure spending and whether those dollars are going towards building resilience and addressing priority climate risks and vulnerabilities. Recognizing that the private sector also plays a key role in building climate resilience through infrastructure, this objective also considers how private investors are integrating climate change into their investment strategies and financial decision-making.

36. Number of Canadian institutional investors that have integrated climate change adaptation or resilience considerations into their investment strategies

This indicator recognizes the key role the private sector plays in building climate resilience through infrastructure, assessing the extent to which institutional investors are integrating climate change adaptation into their investment strategies. Investors can have an important influence on resilient infrastructure through direct investments in Canadian infrastructure and indirect investment through ownership / debt financing for Canadian infrastructure service providers across various sectors, such as home building, construction, and telecommunication companies.

37. Percentage of total government infrastructure spending directed to building resilience towards locally-identified high priority climate risks (as identified by community climate vulnerability assessments)

This indicator measures what portion of government infrastructure spending is directed to addressing climate risk vulnerabilities. The indicator is framed in a way that acknowledges that climate resilient infrastructure is determined by its specific context, regionally-specific climate projections and impacts, and the needs of the local community.

38. Amount of investment ($) directed to critical and climate resilient infrastructure (as defined by the recipient community) for Indigenous Peoples, including telecommunications, transportation and energy infrastructure

This indicator documents financial investments in critical and climate resilient infrastructure for Indigenous Peoples. Often Indigenous Peoples are lacking certain basic infrastructure or are in regions that are more exposed to the impacts of changing climate (e.g., northern or coastal communities). Infrastructure investment in these communities must therefore be prioritized.

Objective 3: Protect and enhance natural and cultural assets and better integrate them into design, planning and investment decisions to enhance community and ecosystem resilience

This objective focuses on the importance of natural assets and ecosystems in enhancing climate resilience. Natural assets tend to be more flexible, cost-effective and easier to adjust and adaptively manage as future climate conditions become clearer as compared to traditional built infrastructure. Natural assets also tend to perform well across a wide range of conditions, and offer a wide variety of benefits across food, water and energy systems, as well as other health benefits to society and the ecosystem. For example, healthy wetlands purify water and mitigate many of the impacts of extreme precipitation that can result in flooding. Finally, where traditional infrastructure exists, natural infrastructure can enhance, protect, or increase its useful life by retaining sediment or reducing the need for maintenance (such as dredging reservoirs). Similarly, roads that are shaded from extreme heat by trees may last longer than those that are exposed.

39. Percentage of total government infrastructure spending directed towards natural infrastructure

Infrastructure dollars have typically been dedicated to supporting the design and construction of traditional grey infrastructure. In recent years, recognition of the importance of green or natural infrastructure to support grey or as a substitute for grey have seen it included for funding consideration. This indicator would measure the uptake of and investment in natural infrastructure solutions as a tool for climate adaptation in comparison to traditional or grey infrastructure.

40. Percentage of communities (regional, municipal, Indigenous Peoples) that have natural and cultural asset management plans

Natural infrastructure could be integrated into infrastructure planning and design through land use planning, asset planning and management, engineering, and urban design. To ensure the longevity and resilience of the natural systems that are integrated, future climate conditions and the types of species and ecosystems that will thrive in those conditions must be considered. For this indicator, the Expert Panel assumes that a natural assets valuation and forward-looking climate change scenarios would be incorporated into a natural asset management plan, as would a local climate vulnerability assessment. Indigenous Knowledge Systems and other ways of knowing could be incorporated into natural and cultural asset valuation and management plans, as appropriate.

Objective 4: Maintain or improve levels of infrastructure services considering a changing climate

This objective considers the operation and maintenance of infrastructure and the reliable delivery of infrastructure services. This objective acknowledges that climate resilience is not only relevant to planning and design, but also to operation and maintenance. This is, in part, because updated policies and standards may only apply to new builds when a substantial portion of the infrastructure that will be relied on in future decades is already in existence today. Ideally, retrofits should also be undertaken to update existing infrastructure and improve its resilience, but there are challenges such as prohibitive costs that may limit the ability to do so.

41. Number of days of disruption to basic services and critical infrastructure

This indicator acknowledges that where and how critical infrastructure is built, whether and how it is monitored and maintained and what emergency response measures are implemented will all reduce the potential for disruptions to basic services. Adaptive measures should be taken to prevent any disruption to basic services and critical infrastructure. Inadequacies in these basic services for Indigenous Peoples should be prioritized ahead of enhancing these services for other communities.

42. Number of infrastructure operation and maintenance plans that have integrated climate resilience considerations

This indicator focuses on maintenance and operational approaches to climate change adaptation. In addition to design and planning, maintenance and operation are important for ensuring that Canada is prepared for more extreme events and the changing frequency and severity of otherwise normal events. This indicator could be relevant to existing infrastructure, and to ensuring that new infrastructure continues to meet relevant climate-resilient standards throughout the course of its lifetime.

43. Number of infrastructure owners and operators that have integrated climate resilience into their planning, infrastructure investments, operations and strategy

This indicator was identified by the Expert Panel in recognition of the key role that both public and private sectors play in ensuring safe and reliable delivery of infrastructure services in light of a changing climate. This indicator would capture the following sectors, among others: aviation, electricity distribution and transmission, electricity generation, gas distribution and transportation, ports and lighthouses, public bodies, regulators, road and rail, and water. Relevant items to report would include the results of a climate change risk assessment, whether owners/operators have drawn up adaptation plans and what those plans include, measures related to emergency planning such as backup power requirements, etc.

Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action

Given the interconnectedness of climate related drivers, a thoughtful approach to mobilizing information and knowledge involving holistic solutions and strategic systems thinking is necessary. The Pan-Canadian Framework on Clean Growth and Climate Change acknowledges that "data, tools, and information need to be widely accessible, equitable, and relevant to different types of decision-makers in different settings and that translating knowledge into action takes leadership, skilled people, and resources," and articulates the importance of Indigenous Knowledge Systems in regard to understanding climate impacts and adaptation measures (Environment and Climate Change Canada, 2016, p. 28-29).

For Canadians to build and improve resilience to climate change impacts, it is essential to continually develop and update climate change information, tools and products that can guide adaptation strategies and action. However, without adequate translation of scientific knowledge, no action will take place; with inaccurate translation of knowledge, the wrong actions may take place; with ineffective translation of knowledge, some groups may lack understanding, be excluded, or fail to act at crucial junctures (Meinke et al., 2006). This chapter focuses on how climate change adaptation knowledge is developed, and how to build the capacity and incentive to both create and act on it. It outlines ways to measure effective development of the tools and resources that can help to achieve these actions through knowledge mobilization and translation.

Context

Translating scientific information and Indigenous Knowledge into action is one of the five areas of action identified under the adaptation and climate resilience pillar in the Pan-Canadian Framework on Clean Growth and Climate Change. This chapter builds on the assumption that previous chapters of this report have identified approaches designed to advance adaptation in a way that requires a knowledge base to achieve action, in addition to key knowledge products, e.g., flood risk mapping and new codes and standards or plans for business continuity. The other chapters have also identified areas, audiences and sectors that require knowledge-based processes to advance action on adaptation, e.g., who and what are likely to be affected, and how adaptation could be achieved.

Awareness by "local stakeholders of local vulnerability to climate change and the perceived and actual risk" is a main driver of adaptation action (Hansjurgen and Heinrichs, 2014); however, it is evident that awareness is not sufficient - people must both care enough to act (Moser, 2014; Moser, 2016) and have the capacity to do so (Ford, 2015). This is especially important as climate science has become more specialized and fragmented by various groups of experts, and the gap is widening between experts and non-experts, including politicians and decision-makers. This gap between science producers and science users makes it more difficult to move from climate change science to climate change action (Naustdalslid, 2011).

Mobilizing knowledge-based action and ensuring that both Indigenous Knowledge Systems and scientific information are being used in decision-making will ultimately build resilience in Canada. The translation of credible and robust knowledge into action is required to reduce the risks and seize opportunities related to climate change adaptation. These approaches must include, respect, and leverage both Indigenous Knowledge Systems and scientifically-derived studies. The importance of "strengthening the collaboration between Canadian governments and Indigenous Peoples on mitigation and adaptation actions, based on recognition of rights, respect, cooperation, and partnership" (Environment and Climate Change Canada, 2016, p.3) is a key priority in climate action planning, and "Indigenous-led community-based initiatives that combine science and [Indigenous] Knowledge can help guide decision making" (Environment and Climate Change Canada, 2016, p.29). Thus, this chapter acknowledges the importance of building an understanding of and including Indigenous Knowledge Systems and their approaches in climate change adaptation, as appropriate, going forward.

Indigenous Peoples in Canada are specifically challenged by a lack of trust, disproportionate exposure to risk, and lack of capacity stemming from legacies of colonization. These challenges will require focused attention to build the relationships required to both develop climate change adaptation plans that are based on Indigenous Knowledge Systems and strengthen the capacity for Indigenous Peoples to act independently and meaningfully on adaptation. Respectful interaction with Indigenous Knowledge holders and building both processes and capacity for Indigenous Peoples on adaptation requires significant and ongoing investment to build trust, as Canada commits to a more balanced approach of incorporating Indigenous Knowledge Systems in decision-making through self-determination. This effort will provide benefit to all Canadians given the thousands of years of inherent wisdom in these knowledge systems, as well as immediate and current knowledge of climate change effects in the present day.

Indigenous Knowledge Systems are grounded in generations of place-based observations and experiences expressed through stories, values, ways of knowing and beliefs that define how climate change is perceived, understood and responded to. Indigenous Knowledge Systems therefore offer perspectives and options for action that can be enacted independently of scientific knowledge or combined with it to broaden perspectives. It is crucial to articulate the nature of Indigenous Knowledge Systems, what is needed for it to be prioritized, and build an understanding of how researchers, practitioners and decision-makers can work with Indigenous Knowledge Systems to advance adaptation.

Considering these points, and in developing the framing for this chapter's indicators, the following **Guiding Principles** were followed:

- Acknowledge that all Canadians have a right to comprehensive and understandable information related to all publicly funded climate change research in Canada.
- Promote transparency and accountability within research, policy and decision-making.
- Promote/support data, information, research, projects and policies that recognize priorities of the host region.
- Include Indigenous Knowledge holders in agencies and governance structures associated with adaptation funding allocations and priority setting.
- Work to address the socio-economic inequities that hinder Indigenous involvement in research.
- Recognize the legacy of colonization and the related effects of science and research on Indigenous Peoples, and work to strengthen relationships.
- Respect that Indigenous Knowledge Systems are a distinct knowledge system (epistemology) that does not require integration into other epistemologies or external validation to be legitimized.
- Understand that Indigenous Knowledge Systems and science are not competing, entirely different or conflicting epistemologies.

Considerations for Measuring Progress

To measure progress on translating scientific information and Indigenous Knowledge into action, it is important to measure whether key members of these audiences both understand and care about the need to act on climate change (Moser, 2014; Moser, 2016). It is also important to measure whether Canadians have the capacity to act in a way that can achieve results. This requires developing an understanding of the issues and potential solutions, producing resources and communication measures that provide access to this information in formats that suit the needs of different audiences and that build their capacity to act on this information, and dedicating efforts directly intended to drive mobilization and implementation.

It is increasingly clear that development of both data and tools is most effective when these processes are developed in partnership with the people who will use the knowledge that results (Naustdalslid, 2011; Dilling and Lemos, 2011; Hegger, Lamers, Zeijl-Rozema, and Dieperink, 2012); when knowledge produced is salient, legitimate, and credible (Cash and Buizer, 2005; Meinke et al., 2006); and when knowledge users can perceive the benefits in their own local context (Dilling and Lemos, 2011; The Climate Knowledge Brokers, 2015). Wherever possible, therefore, knowledge and solutions should be co-produced with users, and respectful to priorities identified in the host area. Working collaboratively to both co-create and disseminate knowledge on impacts and solutions is essential, since resources and solutions are more likely to be used and implemented if knowledge users, knowledge holders, local experts and stakeholders participate in their development.

Furthermore, investment in incentives and capacity will ensure that Canadians are using the resulting knowledge to advance adaptation planning and action. It is therefore essential to understand and create the conditions needed to advance action, which include co-production of knowledge that equally engages users and their needs and values, capacity building at individual and organizational levels, and providing the means to mobilize knowledge through the awareness and planning stages to implementation.

Canadians expect all levels of government (i.e., federal, provincial, municipal and Indigenous) to identify, resource and direct actions that will reduce risk and provide protection for citizens, with different responsibilities based on jurisdiction. They also look to governments to provide guidance and support for individuals and groups to be able to resource themselves to act appropriately on risk, particularly in terms of health, safety and property. This is especially important for vulnerable populations, including northern and Indigenous populations, and young Canadians who will inherit the effects of climate change and be a large part of the community that will sustain the effort on adaptation. All levels of government, therefore, have a significant role to play in terms of supporting the actions and capacity-building needed to enhance climate resilience.

However, the scope of action required on adaptation extends beyond governments. Indeed, complimentary climate action, notably in data sharing, is required from individuals, NGOs, the private sector, professionals and practitioners, academic researchers, boundary organizations and other experts, and community groups.

Potential sources of data are numerous and range from the census, to surveys undertaken by national bodies, to local monitoring, to governmental reporting mechanisms at every level. Climate change science provides historical data and trends, as well as projections of GHG emissions over time and associated projected changes in weather patterns. This data can be used to inform assessments of projected impacts such as flood extents, land changes or issues with air and water quality, which, when combined with mapping of populations and infrastructure, can assist identification of specific risks and/or opportunities. Challenges lie in the fact that data must be updated regularly to remain relevant in a scientific field that is rapidly evolving, a process that requires long-term monitoring, data gathering and analysis. Using this information effectively also requires coordination among Indigenous, local, provincial/territorial and federal governments.

The same challenges apply for measurement of both capacity and action – the variety of actors, scales of action, needs, and perspectives illustrate the complexity inherent in acting on adaptation. For instance, the gathering and incorporating of local observations and Indigenous Knowledge Systems are an essential component of the data collection process (Environment and Climate Change Canada, 2016), enabling the production of tools and other resources to support responses to risks or opportunities, including actions such as the identification of community values, planning, policy development, and implementation. Such activities require capacity that local communities often do not have; consequently, collection and storage of high quality data is often difficult.

Likewise, developing knowledge products that are widely effective can be challenging due to the localized nature of climate change impacts, which requires the development of solutions tailored to individual locations, situations and values. The work required to co-produce knowledge that is relevant and timely is labor-intensive and requires development of relationships that can provide a foundation for action, without which adaptation is unlikely to be successful. However, the importance of these activities is often underestimated and under-resourced, and in some cases even discouraged, for instance, the absence of incentives for co-produced work in academia.

Some organizations aim to gather and develop specific data, translate and communicate findings or engage specific groups (Dilling and Lemos, 2011; Kirchhoff, Esselman, and Brown, 2015; The Climate Knowledge Brokers, 2015), while others contribute information at different stages, model specific Indigenous Knowledge Systems approaches, or connect the national and international realms by developing and transferring climate change technology systems (Ockwell and Byrne, 2015). Boundary organizations (see Box 12) can play a critical role in the interface between diverse groups to help support and develop co-production of knowledge.

However, it is important to acknowledge issues of privilege associated with the capacity and agency to act on climate change. There are systemic barriers that must be addressed to enable equal opportunities to act. This is especially true in the context of Indigenous Peoples and Indigenous Knowledge Systems, which have historically been excluded from decision-making in favour of science. Measuring progress under this area of action will require a greater understanding of Indigenous Knowledge Systems and their vital role in advancing climate resilience in Canada. Building trust, alignment of messaging and material to specific audiences, capacity building and Indigenous Knowledge Systems collection and sharing will lead to more robust adaptive decision-making across the country.

The needs of youth, who may not have the skills and expertise to act on climate change yet are both a vulnerable part of the population and the group that will face the intense challenges associated with future climate change, must also be considered.

Society has sufficient information to warrant sound responses to current and future climate change impacts through adaptation; however, the availability of information does not guarantee that it will be used, nor that it will be used effectively (Naustdalslid, 2011). Therefore, consideration of how information is produced, and how we build both the capacity and incentive to act on knowledge (Dilling and Lemos, 2011; Moser, 2014; Moser, 2016; Naustdalslid, 2011) are key aspects of translation of knowledge into action. Successfully translating knowledge into action will catalyze proactivity on addressing climate risks, recognize GHG mitigation and other co-benefits, and establish resilience to current and future climate change impacts.

In the context of achieving climate resilient systems, objectives and indicators in this chapter are meant to be used in conjunction with existing planning and action systems and integrated with other indicators in this report.

Recommendations

Three key objectives were identified to frame the indicators for this chapter. The objectives follow a logical sequence of knowledge generation, building the capacity to use knowledge, and the effective use of knowledge in decision-making. In some cases, sub-indicators are stated, which either outline more context-specific options for implementation or variations of the indicator for which data may be more readily available.

Objective 1: Indigenous Knowledge and science systems are invested in and respectfully utilized equally and/or together for adaptation knowledge production

The production of knowledge to support adaptation decision-making is the foundation for climate resilience. Recognizing the importance and unique facets of Indigenous Knowledge Systems and fostering their growth and development will support adaptation at many levels. Investment in knowledge co-production is also key and measuring efforts in this area will foster its importance for adaptation decision-making.

44. Number of community-based climate-related monitoring and adaptation programs that include Indigenous, local and scientific knowledge

This indicator tracks the community level programs that explicitly include information and knowledge from diverse sources. Community monitoring programs are important to help get people involved in observing changes, understanding them, and subsequently acting upon them. It also includes the number of adaptation programs and/or platforms promoting culturally sensitive and ethically appropriate data collection and analysis.

45. Amount of federal, territorial/provincial or municipal funds invested in development of up to date, accessible, relevant, co-produced, localized, equitably distributed information on climate and environmental data for both regions and sectors that can be used to support planning and decision making

This indicator tracks the funding allocated by all levels of government to developing and making accessible information on climate change designed to support planning and implementing of adaptation actions. Sustained funding that is made available to a variety of data producers and provided through programs that ensure equality in project design is essential to development of relevant, up-to-date, adequately detailed data. This could include items such as base mapping flows, property, aerial photos, social vulnerability maps, rain and flow data, and weather/climate station data.

46. Number of adaptation-related research, knowledge and action materials and resources developed across themes and sectors for climate change

This indicator tracks the extent of knowledge and resources developed to support action across all themes and sectors. For example:

- Number of different topics covered by academic publications on adaptation
- Number of academic publications and grey literature on adaptation working with multiple ways of knowing
- Number of defensible, standardized adaptation planning tools, policies and guidelines developed to inform decisions and recommended actions
- Percentage of provinces and territories with access to up-to-date climate services tailored to local circumstances

47. Number of codes and standards developed that refer to, or address climate change and adaptation

This indicator tracks the existence and development of codes and standards that provide guidance on best practices designed to factor climate change into crucial aspects of Canadian development and other infrastructure and economic activity. Codes and standards are a clear demonstration of the transfer of scientific information to action to support climate change adaptation.

Objective 2: Canadian individuals and organizations have increased capacity for participation in adaptation

Access to, and capacity to use, Indigenous Knowledge Systems and scientific information will support adaptation decision-making. It is imperative that information be made available and in the appropriate format to the wide range of end-users that require it, but it is equally important that end-users develop the capacity to understand and use the information.

48. Number of training or capacity building programs that demonstrate the application of Indigenous Knowledge Systems and/or scientific information in the context of climate change adaptation

This indicator measures the number of training and capacity-building programs for climate change adaptation that explicitly use Indigenous Knowledge Systems and/or science. Such programs are essential for development of expertise on adaptation at all points along the chain from knowledge to action, including planning, decision-making, funding, implementation, and operations and maintenance. For example:

- Number of programs offering training on the land for young Canadians
- Number of educational offerings, including within existing programs, providing adaptation training (school boards and universities could track)
- Number of boundary organizations working on adaptation knowledge development and translation

49. Percentage of Canadian professionals across sectors who have training in adaptation

This indicator measures the number of Canadian professionals across sectors who have training in climate change adaptation approaches, actions and best practices. Measuring the uptake of climate information in professional practice across sectors could reveal key insights into progress and encourage more widespread uptake and implementation of adaptation knowledge, strategies, and best practices.

Objective 3: Climate change adaptation knowledge developed using the approaches outlined in Objectives 1 and 2 is being translated into action and implemented in plans and practices at multiple levels and scales

Objective 3 seeks to drive the implementation of information and knowledge in decision-making at various levels and measure the outputs that stem from this action. Measurements from these indicators will reveal ways in which knowledge translation has effectively taken place.

50. Extent of each province and territory covered by adaptation plans incorporating climate risk assessments, designed to be updated every 5 years

This indicator tracks the extent of coverage of adaptation plans developed across Canada. This will indicate how prevalent and integrated adaptation plans with climate risk assessments are in Canada. For example, for the following sectors and groups:

- Number of Indigenous-led plans
- Number of youth-led plans
- Number of community and regional government plans
- Number of industry plans (hectares covered allows for rural/northern regions and industries such as agriculture and forestry)
- Number of national industry association plans

51. Percentage of communities (including youth) implementing actions that support adaptation or increase resilience

This indicator tracks the extent to which communities are acting to adapt to changing climate conditions.

52. Number of federal and territorial/provincial cumulative risk assessments and other environmental assessments that incorporate projections of future climate

This indicator tracks whether cumulative risk assessments and environmental assessments are explicitly considering climate change. It is important to consider cumulative risk assessments because ecosystem health is a crucial factor in resilience to climate change impacts such as flooding and extreme heat, and assessing projects based on individual risk assessments does not capture the accumulation of effects on ecosystems and built landscapes.

53. Percentage of property/casualty insurance policies that incent adaptation

This indicator tracks whether insurance companies and their policies are explicitly considering climate change and promoting actions to reduce risks.

54. Percentage of federal, provincial, territorial, and municipal or non-governmental organization funding allocated to implementation of adaptation actions

This indicator tracks the proportion of funding dedicated to supporting knowledge-based implementation of adaptation actions. Sustained funding for implementation of adaptation actions, provided by programs that ensure equality in project design, is an essential incentive to advance the implementation of adaptation. Appropriate deployment of funds will inform decisions that account for climate change.

Box 12: Boundary organizations – Knowledge to Action Case Study

The complex challenges posed by climate change increases the need to consider climate- or adaptation-related information in decision-making, based on credible, relevant and practical scientific information produced within the context of participatory processes. At the interface between science and decision-making, climate change boundary organizations create and maintain an interactive space for knowledge co-production that is based on active participation of stakeholders to better integrate climate- or adaptation-related information into decision-making. This makes it possible to establish connections and links that align the needs of stakeholders with what science has to offer. Boundary organizations, as well as the climate services they can offer, therefore play a key role in the transfer of knowledge and information associated with climate change. These types of organizations are increasingly recognized as necessary components for successful adaptation to climate change.

Chapter 7: Implementing a Sustainable Approach to Monitoring Progress on Adaptation

A robust M&E program for climate change adaptation provides the supporting and enabling framework through which a geographic region or sector can demonstrate a change in levels of adaptation actions and adaptive capacity and resilience. Adaptation indicators alone are insufficient and require details related to data collection and collation, assessment, reporting and subsequent modification to the tracking system, including indicator modification or development to advance climate resilience. This chapter presents an approach to mobilizing the climate change adaptation indicators developed by the Expert Panel through a sustainable monitoring and evaluation framework. Outputs from the program are meant to provide information to all Canadians on whether Canada is becoming more resilient to the impacts of climate change and provide insights into where additional efforts are required to adapt.

The proposed climate change adaptation M&E program is broadly applicable. The process, or elements within, can adjust to address M&E needs at different scales or in specific sectors, and like adaptation, M&E action is a shared responsibility. As such, a national program would seek to harness such finer scale application to supplement and support a broader effort to report national scale results. In this case, all data would channel up to a lead agency for analysis and reporting.

Monitoring and evaluating climate change adaptation is important for many reasons. It demonstrates whether adaptation interventions are effective at reducing climate change vulnerability and risk, whether the benefits of adaptation outweigh the costs of implementation and whether the interventions are effective across regions or populations (Hamden and Associates, 2017). Adaptation M&E also fosters learning about new adaptation requirements in an ever-changing and multi-faceted risk environment and modifications to improve the M&E program itself and provides a level of accountability for policy and program implementation (Spearman and McGray, 2011).

The non-linear and uncertain nature of climate change, combined with the breadth of impacts, requires adaptation at many scales, in different sectors or interests and by multiple actors. As such, adaptation M&E can be implemented at different scales and by different actors and enable self-evaluation against selected criteria. National-level adaptation M&E is increasing around the world. Several countries, including Germany, the United Kingdom, France, Austria, Finland, and Australia, have developed and implemented national level adaptation M&E programs; while each program is unique in its motivations, foundations and objectives, all are designed to determine whether a country is becoming more resilient to climate change.

A sustainable adaptation M&E program will take advantage of existing indicators, programs and data collection arrangements. The open data movement and continuous improvements to data access should facilitate sharing and uptake of knowledge and information to support adaptation. Indigenous Knowledge Systems provide tremendous potential to understand how traditional lands are being affected by climate change and how Indigenous Peoples are making progress on adaptation. The M&E program design should facilitate this sharing and learning, and M&E results should promote ways to improve adaptive capacity in vulnerable regions and for Indigenous Peoples.

The goals for Canada are like those of other nations — to understand how, where and to what extent we are becoming more, or less, resilient to climate change. Measuring progress would help ensure targeted, efficient and effective investments in adaptation and protect Indigenous Peoples and cultures in Canada for current and future generations. The ultimate success of a Canadian climate change adaptation M&E program will stem from several key factors:

1. The ability to respectfully work with Indigenous Peoples and Indigenous Knowledge Systems to measure progress on adaptation and respond to M&E results to improve capacity and resilience with Indigenous Peoples;
2. The willingness to improve both the indicators and the M&E program in a timely manner and over time, largely stemming from the rapid evolution of climate change science and the effectiveness of efforts to adapt; and
3. The ability of M&E results to inform a baseline from which future adaptation can be measured.

The proposed Canadian climate change adaptation M&E program is an important first step to demonstrate the effectiveness of adaptation to date. However, learning from the first iteration of the process is important for continuous improvement of the ability to detect and report on changes to climate resilience. The final vision or target for resilience is difficult to define for climate change adaptation since it requires thinking beyond a known experience. The pervasive nature of climate change, and the plethora of actions that seek to counter the risks, make the definition of an acceptable level of performance most challenging. The desired future state is also set against the backdrop of an ever-changing suite of environmental, societal and economic conditions that confound direct lines of attribution to adaptive measures. However, M&E for adaptation is an integral part of the adaptation planning process and one that defines whether any marked difference is evident. M&E itself helps to adapt.

Essential Tenets of Climate Change Adaptation Monitoring and Evaluation

M&E programs for climate change adaptation have several common themes. Programs can be used to help track implementation and effectiveness of various scales of adaptation strategies, frameworks or programs. For example, the 2008 Climate Change Act in the United Kingdom requires that the government issue a National Adaptation Program, informed by a climate change risk assessment that is conducted every five years. The National Adaptation Program provides the basis for monitoring preparedness for climate change in the UK and its M&E program evaluates the effectiveness of adaptation at reducing climate change vulnerability and risk.

M&E programs can also measure efficiency, that is, statements about the degree of progress toward the desired outcomes of adaptation measures given the resources dedicated to them. Adaptation M&E also provides accountability to the public or other groups, stakeholders or governments for investments, policies, programs or individual actions on climate change adaptation.

Indicators can be used to measure aspects of process, outputs or outcomes that stem from monitoring adaptation. Process monitoring refers to the tracking of policies, plans and/or interventions implemented for climate change adaptation, and/or institutional capacity to do so (Olivier, Leiter, and Linke, 2013). For example, *Percentage or number of communities with development and re-development 'build back better' control policies, bylaws and regulatory tools for climate-related hazards that are culturally appropriate and include Indigenous Knowledge Systems where appropriate* (Chapter 4: Reducing Climate-Related Hazards and Disaster Risks) is an example of a process indicator. The measures are implemented with the realistic expectation of successful adaptation outcomes. Output monitoring constitutes some measure of the tangible and immediate results of an adaptation action or plan. For example, *number of key members of community (e.g., police, firefighters, water technicians, harvesters) with safety training and equipment to adapt to changing conditions* (Chapter 3: Supporting Particularly Vulnerable Regions) is an output indicator. Finally, outcome-based tracking reveals the change in resilience, levels of risk or adaptive capacity because of adaptation actions (Hamden and Associates, 2017). For example, one outcome-based indicator recommended by the Expert Panel is: *Number of days of disruption to basic services and critical infrastructure* (Chapter 5: Building Climate Resilience through Infrastructure). The results of all three types of monitoring allow us to learn and adjust the adaptation response as necessary.

In addition to reporting on adaptation progress across the areas of action defined under the Pan-Canadian Framework on Clean Growth and Climate Change, the entire system (or aspects of it) can be applied at other scales. National level adaptation M&E is scalable and can be implemented by individual sectors, interests or regions to gauge progress on adaptation. This creates the potential for nested or layered M&E to be conducted within the auspices of a national program, fostering different rates of learning and refinement of indicators within both the national-level M&E program and at other scales. It is also supportive of the recognition of gaps in the M&E process, inspiring additional 'coverage' to make the system more robust.

There are several key considerations that inform development of a climate change adaptation M&E program. The availability of existing indicators and their data are fundamental. Measurement fields for adaptation are broad and require information from various sectors and/or regions, thus data and information availability, format, mechanisms for collection and transferability are required to develop indicators and report on the state of adaptation. Subsequent steps that enable coordination and analysis of data for a region, sector or theme provide mechanisms for producing results that reveal the adaptation or resilience trend, and its translation into appropriate material for reporting to a variety of audiences. A clearly defined path of data flow, along with roles and responsibilities of various data sharing participants, helps to maintain efficiency in the M&E system and limits overlap or confusion among the various contributors.

A robust system also includes levels of engagement with those who are closest to adaptation implementation and policy/program development, including Indigenous Peoples. These groups play key roles in the M&E process as they experience firsthand the impacts and climate change risk, help define resilience objectives, or implement adaptive solutions. The combination of these broad perspectives creates the fulsome narrative of changes in climate resilience beyond the results of a single indicator and can inform ongoing adjustments and improvements to indicators and the M&E process writ large.

Lastly, resilience indicators and their M&E program are the means through which adaptation is measured. However, learning from the results and the measures taken to improve effectiveness of adaptation is the goal. Without learning and adjustment stemming from the M&E results, program objectives are not met.

Research conducted for European Union (EU) members' adaptation M&E plans indicate eight common elements among effective programs. Key elements or themes in the EU adaptation M&E programs include: effectiveness (objective achieved) and efficiency (adaptation through most appropriate means) of adaptation, accountability (action justification), assessing outcomes (risk reduction), learning (about adaptation response), equity (unequal and disproportions of risk), transparency (disclosure of adaptation results) and engagement (effective communication).

Challenges and Key Considerations

Development and implementation of an effective and efficient monitoring, evaluation and reporting program for climate change adaptation can be challenging, most notably when conducted at the national level (as indicated in the experiences of researchers and others involved in national-level M&E programs (European Environment Agency, 2015)). Uncertainty associated with future impacts presents significant variability across the breadth of regions, communities and economies, which can be experienced by different people in vastly diverse ways. This all-encompassing impact stressor overlays highly complex and dynamic societal conditions, making it difficult to identify direct attribution from climate change impacts.

The application of adaptive measures also faces similar challenges. Resilience may not necessarily stem from adaptation in the context of evolving communities, and as such, we attempt to define such attribution for adaptation M&E. The long timescales over which climate change unfolds also challenges the relatively short duration of policy and program drivers for adaptation. M&E must seek to capture the longer time frames over which climate change unfolds, as well as the evolution and adoption of adaptation programs. This also gives way to the challenges of establishing baseline conditions in dynamic environments.

The ability to measure avoided impacts is another challenge of adaptation M&E. Adaptation is designed to reduce vulnerabilities and risks that stem from climate change, but it is difficult to know how much worse the impacts would have been in the absence of adaptive measures or policy (Bours, McGinn, and Pringle, 2014a). Other challenges to adaptation M&E include the diversity of concepts and definitions associated with adaptation, the availability of data to support ideal indicators, the lack of a clear objective goal or end state (unlike GHG reduction or carbon sink enhancement for mitigation) and resource constraints (e.g., human, temporal, financial and technical) (European Environment Agency, 2015).

The Canadian context for adaptation M&E includes a significant role for Indigenous Knowledge Systems to inform changes to climate resilience. Indigenous Knowledge Systems are a way of knowing and thinking that transcends other forms of monitoring and data collection. As an integral source of information on climate change adaptation, Indigenous Knowledge Systems are a foundation for a rich and comprehensive understanding of how Indigenous Peoples are becoming more resilient. A fulsome and robust M&E program for Canada recognizes and values the unique living process of multigenerational observation of climate change and resilience from Indigenous Peoples, along with data and science from other sources, feeding into a step-wise process to inform results. Indigenous Knowledge Systems also provide unique and valuable guidance for development of future indicators and refinement of the M&E process itself at time scales appropriate for the knowledge holders.

A Framework for Adaptation Monitoring and Evaluation

The following section defines a framework for monitoring and evaluation of climate change adaptation in Canada. While the process provides specific detail for a national program, elements of the process could be adopted to suit M&E needs at other scales or in specific sectors. The framework has six steps, each defining a key facet of an effective and efficient program. Coordination within each step (within lead coordinating entity) and between steps (lead coordinating entity – enablers) is suitably conducted by a dedicated entity and/or many entities, with the requirement for one lead coordinating entity for reporting at a national scale.

A national entity must play the **lead coordinating role** for adaptation M&E, which would be enabled by numerous different players across the Canadian adaptation landscape. Although the data may be collected at various levels and through various partners, all data would funnel up to the lead agency and report issued by that agency. For implementation at other scales, coordinated data collection, and other aspects such as analyses and reporting would be similarly scaled. Related to the coordinating role, and for sustainability, efficiency and complementarity with program features, the Canadian adaptation M&E program could be **located within or alongside an existing M&E/indicator program**. The adaptation M&E program should use **existing data collection agreements** if possible. Indicator development in other areas of monitoring and evaluation place primary emphasis on the availability of data which are often collected using existing agreements or arrangements. It is possible that many of the data required for new indicators for adaptation do not have existing arrangements and as such would have to be developed at appropriate scales and with appropriate parties.

The **reporting period** for results on adaptation monitoring and evaluation could be annual but is dependent on data availability and collection processes. It is possible that indicators are reported in a range of cycles; that is some annually, some biannually or every five years. Each year, the lead agency should produce a report that reflects the results of all indicators on the list. The timing of report issuance would respond to pre-determined timelines and influence previous steps to collect data and analyze for trends. Reporting periods should recognize unique timing of collection, preparation and reporting of Indigenous Knowledge Systems, as well as scientific data collection periods and other annual reporting structures. Reporting may also be aligned to inform key decisions on climate change adaptation program funding.

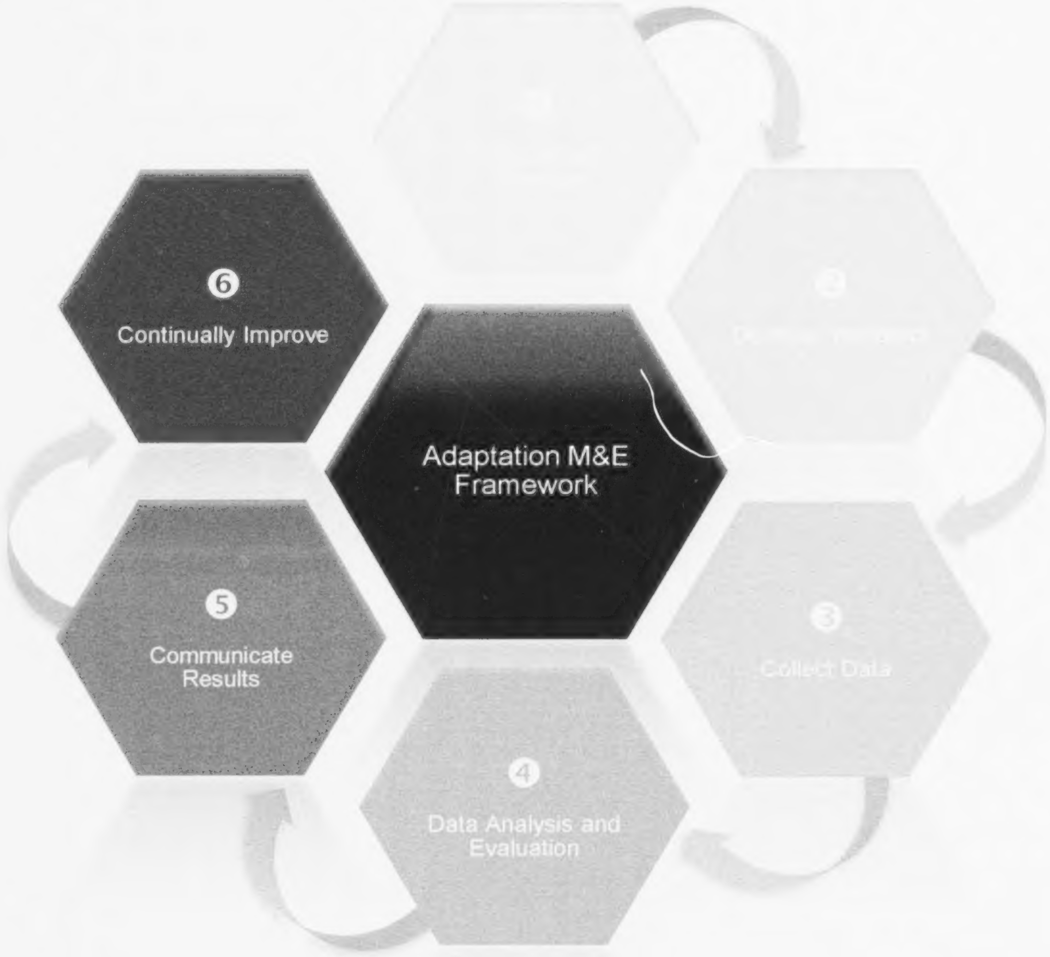
Indigenous Knowledge Systems are a unique and critical input for monitoring and evaluating climate change resilience in Canada. The Canadian adaptation M&E process should include Indigenous Knowledge Systems as it pertains to the indicators and measurement of adaptation and resilience, as well as guidance for development of future indicators and refinement of the M&E process itself at time scales appropriate for the knowledge holders. Sharing arrangements for Indigenous Knowledge Systems and data are undefined but acknowledge the need for consultation on their development.

Communication of the results can come in different formats and should be tailored to several types of external audiences. The format of results could also be reviewed by those who contribute to either the provision of data or sharing of knowledge. Reporting approaches could also be considered based on other external factors, such as timing related to other events or announcements, introduction of new policy or implementation of new adaptation programming.

The entire M&E program is meant to follow tenets of adaptive management. In this sense, steps in the process are flexible, expandable and adaptable. Each step in this process, as well as the process as a whole, is designed to change with application and learning. With emphasis on the first iterations of the M&E program, careful examination and assessment of all aspects of the program should lead to M&E program refinement and expansion, in an evolution toward a more detailed, efficient and coordinated program which can demonstrate changes to climate resilience in Canada.

Figure 2 outlines the proposed six-step process for climate change adaptation monitoring and evaluation in Canada, with subsequent description of each of the steps.

Figure 2: Six Step Process for Monitoring and Evaluating Climate Change Adaptation and Resilience in Canada


Adaptation M&E Framework
2
3
Collect Data
4
Data Analysis and Evaluation
5
Communicate Results
6
Continually Improve

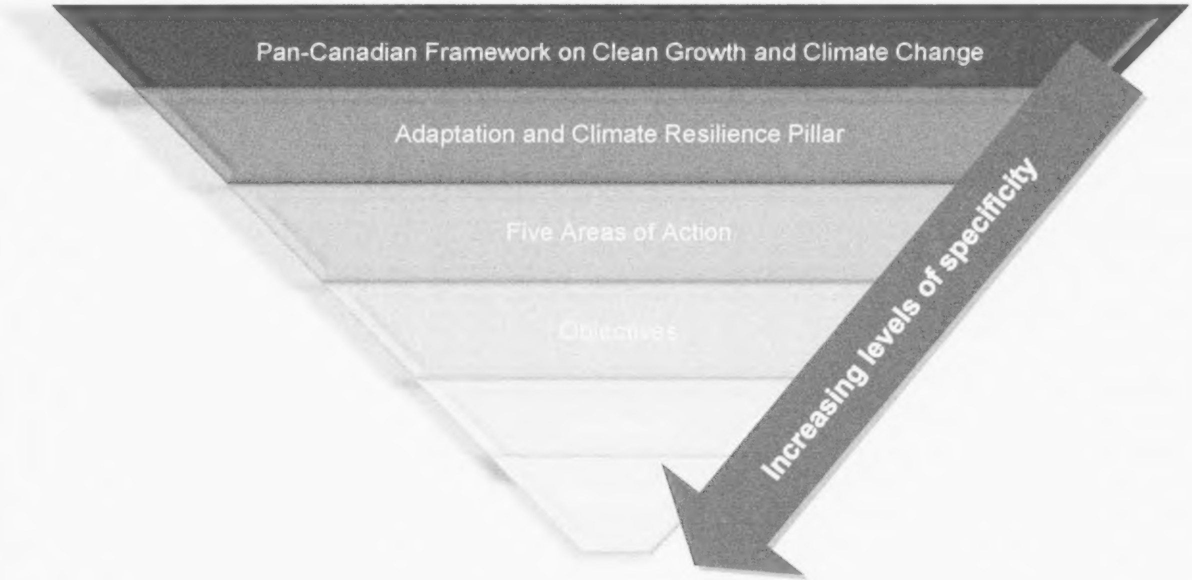
Step 1: Purpose and context

Adaptation
M&E
Framework

The Expert Panel developed a suite of specific objectives and indicators across the five areas of action of the adaptation and climate resilience pillar of the Pan-Canadian Framework on Clean Growth and Climate Change. Adaptation or resilience objectives in each of the five preceding chapters provide context for the purpose and vision of future states of resilience in Canada. Results that stem from measurement are meant to show both how climate risks are changing and what further action is needed to move closer to the desired future state or objective. For example, under Chapter 6: Translating Indigenous Knowledge and Scientific Information into Action, the first objective is *Indigenous and Western science knowledge systems are invested in and respectfully utilized equally and/or together for adaptation knowledge production*. Scheduled iterations of the process should start by understanding if and how the purpose and context have changed, or whether the objective of future desired state requires adjustment.

The indicators defined in chapters 2-6 are both process- and outcome-based, and measure attribution (capacity in place to implement and lines of evidence to measure) as well as contribution (implementation contributed to resilience outcomes). Indicators in the preceding chapters are cross-cutting, as some measurements of climate resilience are applicable to more than one theme. In many cases implementation of the indicators would involve measurement at regional or local scales, from which a collective national picture or trend could be derived. As such, it is important to recognize the distinction and relationship between the local or regional vision for resilience and that of the country.

Figure 3: Overview of hierarchy linking national framework to measurement of adaptation


Pan-Canadian Framework on Clean Growth and Climate Change
Adaptation and Climate Resilience Pillar
Five Areas of Action
Objectives
Increasing levels of specificity

The audience should be defined in step one. For M&E results, the audience is broad and could include Indigenous Peoples and organizations, community and municipal decision-makers, federal, territorial and provincial representatives or departments, economic sectors and/or business leaders, and the public. Understandably, some indicators would be of more interest to specific groups, thus language within the reporting documents must recognize the diversity of the audiences and present findings in a clear manner. The lead coordinating entity may also consider special reports that are unique to any of these audiences. These considerations are linked to step four in this process.

Step one also includes an initial mapping of the different entities involved in the M&E process and what roles they could play. Decisions about the lead coordination entity, contributors, reviewers, communications and program resources constitute important administrative and coordination roles to support an efficient and effective program.

Since an initial suite of indicators has been developed by the Expert Panel, data collection and reporting (step three) would be the entry point to the process. However, following the first iteration of measurement, analysis and reporting, the process could include an evaluation of the objectives under each area of action for aspects such as relevance, priority, and inclusiveness. Questions such as "Is strengthening and bringing together the right tactic" or "Is investment and utilization what we are aiming to measure" would a) test whether the objective aligns with what is desired by Indigenous Peoples, governments, the public, adaptation practitioners, etc. and b) signal whether adaptation actions in these themes are improving climate resilience. Regional, sectoral or community assessments of climate change risk may also provide additional information that would drive objectives and context direction.

Step 2: Indicator refinement/development

Adaptation
M&E
Framework

The process to identify the initial suite of indicators recommended by the Expert Panel is different from what should be applied to future iterations. As such, step two of the process includes actions to refine the initial suite, as well as actions to develop new indicators.

As mentioned above, indicators for adaptation can be process- and outcome-based. While process-based indicators gauge steps toward building capacity and measuring implementation of adaptive actions, outcome-based indicators seek direct lines of evidence to support a cause-effect relationship between impacts and adaptation that leads to a reduction of climate risk or an increase in adaptive capacity. Both types of indicators are important for adaptation, and both provide information to further enhance adaptation.

Indicators should be developed or refined through a series of criteria that assesses them for suitability in the Canadian context. While an indicator may still be vital even when not all criteria are fully met, the Expert Panel considered the following criteria in recommending the initial suite of indicators:

- Practical – quantifiable or directional (positive or negative) assessment is available;
- Clear – good demonstration and reporting of progress in a negative or positive direction;
- Meaningful – provides actionable insight that is useful to Canadians;

- Cost-effective – can be measured at a reasonable cost and effort;
- Broad-based – nationally applicable where reasonable;
- Dis-aggregable – allows for disaggregation by geography or population group;
- Measurable – presence of metrics and data can be collected or is currently available;
- Designed to drive adaptation behavior in a positive direction.

Subsequent iterations should continue to apply these criteria, but with additional attention on data availability and data/knowledge transfer mechanisms that facilitate the entry of new indicators to measure progress on adaptation. The effort required to establish a new indicator for measuring adaptation can be significantly reduced if existing data sources can be found. However, methods for knowledge/data transfer to the coordinating entity would still be required.

Under step two, the coordinating entity should give consideration to the breadth of the indicator suite to ensure it adequately measures adaptation for all regions of Canada and take steps to add indicators where gaps exist. This could be informed through consultations with sectors or regional stakeholders and/or by new assessments of climate risk. Indicators should be evaluated for their ability to inform progress over extended periods of time, with attention given to not jeopardizing reliability and validity.

From the criteria mentioned above, specific assessments of existing facets of data availability, needs and data flow can be established. The following questions should serve as additional screening criteria, to aid with indicator selection:

- ✓ Data availability – presence of existing data, ability to modify existing data to meet adaptation needs, part of an existing program
- ✓ Data transfer – punctuality, public availability or cost, negotiations required, consultations required, where transferred from and to whom, specific personnel, how data could be transferred
- ✓ Data format – spatial representativeness, applicability to other regions, policy alignment

Box 13: Canadian Environmental Sustainability Indicators (CESI)

The CESI air quality indicators are calculated from National Air Pollution Surveillance (NAPS) data. In existence since 1969, NAPS was established to facilitate and coordinate the collection of air quality data that conforms to quality standards designed to ensure data are reliable, defensible and easily accessible. The NAPS Program is managed and operated by provincial, territorial and regional (Metro Vancouver and Montréal) monitoring agencies across Canada in cooperation with Environment and Climate Change Canada (ECCC). Participation in the NAPS Program is formalized through a MOU between the federal (ECCC), provincial and territorial governments. The MOU is renewed every 5 years.

All NAPS Agencies, monitoring sites and pollutants monitored are specified in the MOU, which outlines the general terms and conditions of cooperation among the parties that participate in overall management and support of the NAPS Program. Representatives of participating federal, provincial, territorial and regional governments meet at least once a year to report on operations, review Program needs and reporting requirements, report on Data Quality Objectives, identify new and emerging technologies, and discuss other information of mutual interests.

With these indicator and data considerations complete, indicators can be added via the negotiation and/or establishment of sharing requirements (e.g., MOU, contract, standard operating procedure) and standard methods for data collection developed.

Step 3: Collect data

Develop Indicators
Adaptation M&E Framework
3
Collect Data

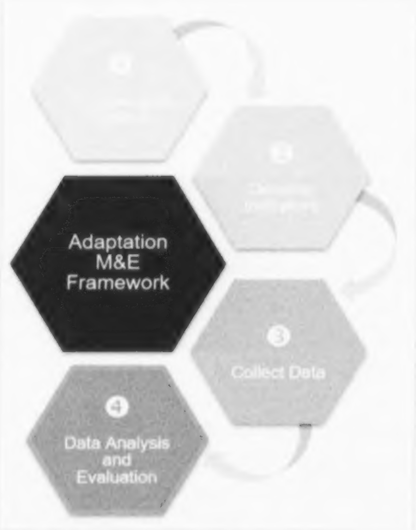
Given that little is known in Canada about current baseline conditions against which progress can be measured, the first iteration of data collection requires assessing knowledge and data that define baseline adaptation or resilience conditions for each of the themes. The dynamic nature of both climatic and contextual (e.g., societal, technological) conditions would require sufficient attention to mark the 'point in time' when data is collected, leading to a score or state against which future measurements could be evaluated.

Indigenous Knowledge Systems and other forms of knowledge form the basis for gauging progress on resilience to climate change. Each of the previously noted objectives and indicators have unique data requirements which, to the extent possible, should be derived from the most appropriate sources, including Indigenous Knowledge Systems sharing forums (with requisite confidentiality conditions) and existing data collection programs. A process could be developed to identify such forums, catalogue existing data exchange agreements and evaluate data availability. In cases where those forums or data do not exist for adaptation M&E, a type of 'data source evaluation' could be conducted, which would explore partnerships and seek ways to develop knowledge sharing and data collection systems to support the indicators listed in this report. An initial scoping of how other jurisdictions have managed the data availability and data relationships may provide insight and inform this step.

In cases where there are Indigenous Knowledge Systems or data that support the indicators, sharing and data agreements should be modified (if necessary) to define access (e.g., knowledge sharing process and conditions for its use) and how the knowledge and data would be directed to a national coordinating entity. To meet the array of data needs, a variety of data collection/reporting relationships should be considered (e.g., Inuit Knowledge Working Groups (IKWG), Federal-Provincial/Territorial, Municipal-Municipal, NGO sources, etc.). Where Indigenous Knowledge Systems support adaptation indicators and given that often the observations of climate change impacts and adaptation are defined at smaller spatial scales (community or territory), coordination assistance from Indigenous organizations may be appropriate.

Additional considerations, such as transfer mechanisms (e.g., oral, electronic); storage (e.g., internal or external database); responsible bodies and reporting hierarchy (e.g., IKWG, departments, organizations, specific people); intellectual property (e.g., sharing arrangements with Indigenous Peoples) and collection and reporting dates/timing (e.g., quarterly, bi-annually, etc.) should also be considered in step three.

Step 4: Data analysis and evaluation



Using the indicators developed in previous chapters, practitioners can record baseline values for comparing conditions before, during, and after the implementation of the intervention. They also should consider the baseline observations when determining appropriate targets for the intervention (Spearman and McGray, 2011). In step four, the climate change adaptation M&E knowledge and data is analyzed for identifying upward or downward trends for each of the indicators. The coordinating entity is responsible for ensuring the quality of the data and, if necessary, employing measures to make the metrics consistent over spatial contexts. Formats for reporting should be defined in advance, be cognizant of, and designed for, target audiences, and match and provide the template or guidance for end products that would stem from the analysis. End products stemming from the analysis should meet the needs of the target audiences. Reporting could include a highlights report, factsheets or reports cards for the public, a summary for policy makers and main stakeholders, and detailed or more technical reports for practitioners.

The coordinating entity should define trends with supporting lines of evidence, and ways to interpret Indigenous Knowledge Systems should be developed in collaboration with those who share the knowledge and other appropriate organizations. This process may differ from other methods used to assess adaptation data or information. For example, for First Nations, it is required that the principles of Ownership, Control, Access and Possession (OCAP) be followed. Data analysis should lead to clear statements about the directional change in resilience for each indicator relative to baselines and/or from the previous reporting period. In addition to the results of the analysis, narrative on the reasons behind the change with possibly direct or indirect attribution/contribution could also be noted. A group of the data players, participants or stakeholders can also be involved in a review of preliminary results and trends, adding to the legitimacy and transparency of the process.

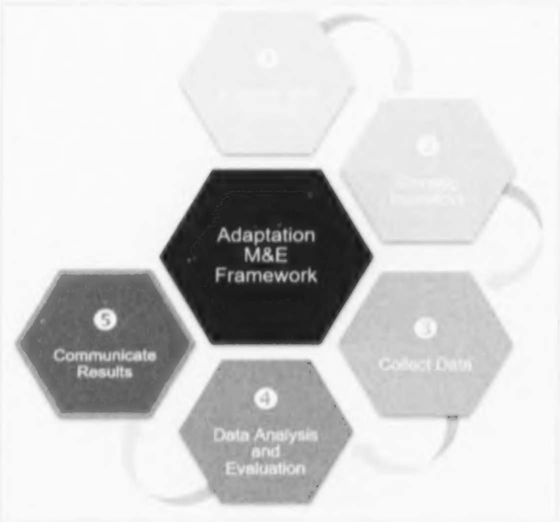
When the results of the data analysis point to directional change in resilience or adaptation (or possibly changes to adaptive capacity), assessing the appropriateness, effectiveness or efficiency of the influencing adaptation measures is important for continuous improvement. If changes are either undesired or insufficient, the results may glean insights into required adjustments for adaptation implementers.

Reporting formats should recognize the potential diversity of audiences to ensure that language is appropriate, and messages are designed for the target audience. Products from this step may include long or short narrative reports, slide presentations, graphics or infographics, or report cards. Specific reports stemming from individual theme analyses (e.g., Translating Indigenous and Scientific Knowledge into Action) or specific or tiered evaluations could also be developed. The details of communication products and actions to disseminate results could be supported by a communication plan.

As part of the overall adaptation M&E continuous improvement process, indicators should be evaluated. In conducting this evaluation, the coordinating entity should consider and note potential improvements to data format, data quality, analysis methods, reporting structure, linkages to resilience, etc.

The collection of data, and, the ultimate reporting or results may also be linked to the release or announcement of larger initiatives such as a budget investment, release of regional risk assessments or the creation of a new Indigenous or regional M&E program.

Step 5: Communicate results



The fifth step in the M&E process entails communicating the reporting products stemming from the analysis of indicator data. More broadly, communication between distinct levels to support data flow and analyses is fundamental to the success of the M&E program and is considered inherent within each of the previous steps.

A communication plan will contain a list of target audiences and timelines to inform sharing of data products with Indigenous Peoples and stakeholders. The delivery should consider a range of communication methods such as specific electronic delivery, posting on web-based information portals and/or providing in hard copy, and various media such as news outlets and social media should be utilized. Release and communication of the full report could be supported with executive summaries, media releases and statements and audio clips.

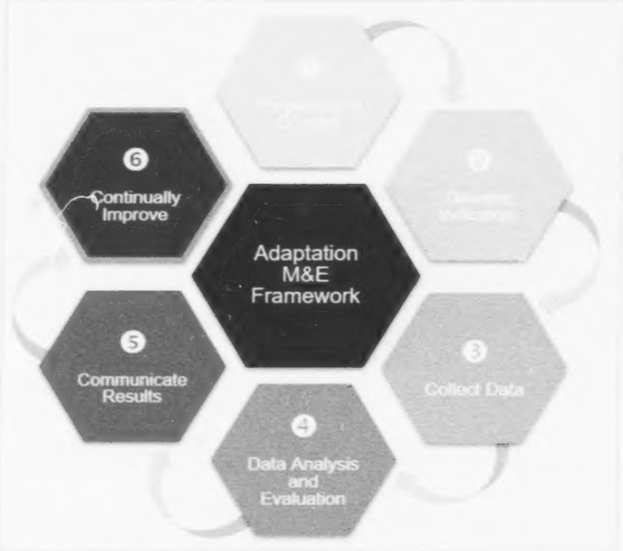
With the wide array of potential contributors to the M&E process, the communication effort should support specific media requests to thematic specialists, such as Indigenous organizations or municipal stakeholders. The tiered nature of the data and analyses may also support development of reports specific to regions, sectors, themes or interests within Canada. If this is the case, those more specific reports should have delivery methods that match the target audiences.

Reporting of the M&E results should be tracked carefully to measure product and message uptake and response. This information can then be used to hone the communication plan for future iterations. Specific feedback could be solicited from the target audiences, which could inform future adaptation M&E communication efforts.

Step 6: Continually improve

The M&E process provides information on trends in building adaptation and resilience, as well as insight into what is needed for adaptation. However, its delivery also inspires learning for indicator and program improvements. In step one, the process begins with the development of program purpose and context, but also the requirement for ongoing refinement to the M&E program. In step two indicators are developed based on thematic or regional gaps which are largely based on an evaluation of indicator coverage, strengths and weaknesses.

M&E is not an end. Rather, the results are an integral part of adaptation management and decision-making on the ground. Therefore, once the monitoring data is collected and the results/recommendations have been reported and disseminated to stakeholders, adjustments can be made to adaptation policies, programs and practices, as well as to the M&E program itself. This also applies to other entities that elect to adopt the M&E program; they are encouraged to extract lessons from the process and expand adaptation efforts in the face of dire climate change impacts.



Step six should compile comments and reflections stemming from the delivery of the program in its previous iteration. It is likely that more adjustments should be made following the first iteration of the M&E program, with likely fewer adjustments needed over time (except for the addition of new indicators). Beyond the reporting cycle, decisions pertaining to a) number and coverage of indicators, b) time allocations to certain M&E steps, c) data/knowledge transfer arrangements, d) data analyses or e) reporting formats could be conducted with subsequent improvements to the adaptation M&E program. The path of how adaptation M&E has continuously improved should be well documented, with evidence for each change.

The suite of indicators used to monitor and evaluate adaptation and resilience should shift over time. As adaptation slowly infiltrates mainstream policy, planning and decision-making in Canada, different areas of measurement will be required, and indicator types should evolve. For example, such a shift could be progression from an indicator used to measure the incorporation of climate change considerations into flood plain maps to an indicator used to measure the number of communities with assets in high flood risk areas (as defined by the flood plain maps). The logic follows that climate-sensitive flood plain maps are a pre-cursor to identifying assets on current and future flood prone areas. In addition to adjustments stemming from program (M&E process/indicator-oriented) learning, external or adaptation-related adjustments are also important. Reports on adaptation progress may also reflect what specifically or broadly is required in the form of adaptation to alter a negative trajectory or fill a gap where measures of resilience are absent. It is possible that, over time, the focus will shift more toward reporting on outcome indicators as opposed to process or output indicators.

Moving Forward

The impacts of climate change are already being felt across Canada, and pose significant risks to communities, health and well-being, the economy, and the natural environment. Limited adaptive capacity and discrepancies in social and economic conditions translate to increased vulnerability for many Canadians, including Indigenous Peoples as well as northern, remote and coastal regions. Taking action to adapt to current and future climate change impacts will help protect Canadians from climate change risks, reduce costs, and support an improvement in society's climate resilience. Monitoring and evaluating changes to climate risks because of adaptation would improve efforts to build resilience in Canada and promote adaptation programming and response in specific and enhanced ways.

A robust M&E program for climate change adaptation provides the supporting and enabling mobilizing framework through which indicators can be applied to measure changes to levels of climate risk. This chapter proposes a sustainable M&E framework to mobilize the climate change adaptation indicators developed by the Expert Panel. The recommended program supports broad application for national-level reporting on adaptation progress, in addition to 'nested' application to measure progress on different scales. The process of M&E is a living one – iterative and ongoing to support a sustained effort on improving climate resilience in Canada.

The recipe for adaptation M&E program success will stem from a commitment from the federal government and other partners. The recommended program's diversity and breadth matches the nature of climate change as a pervasive challenge. The suite of indicators recommended by the Expert Panel is a preliminary one, which could expand over time. From this list, a sub-set of 19 indicators have been identified as a preliminary tranche for immediate implementation. The coordinating entity or federal government may consider which indicators to mobilize first for implementation. A phased and/or pilot implementation is also possible to test the M&E process and establish foundations, while measuring at smaller scales.

Finally, mobilizing the adaptation M&E program at a national scale requires adequate spatial representativeness of the monitoring effort. Significant deficiencies in social foundations and lack of capacity may challenge this representativeness. As such, additional effort is required to address this discrepancy for M&E, to support climate change adaptation.

Definitions

Acute event: For purposes of this report, please refer to the definition of rapid-onset events.

Adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects (IPCC, 2014b).

Adaptive Capacity: The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC, 2014b).

Basic services: Public or private services that citizens pay for through taxes or other contributions. These may include sanitation, water, schools, emergency services, transportation and health services. Closely associated with the definition of critical infrastructure.

Built infrastructure: Engineered assets and systems, such as: roads; ice roads; bridges; buildings; energy, water, wastewater, and transportation systems; telecommunications, etc.

Chronic event: For purposes of this report, please refer to the definition of slow-onset events.

Climate: Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system (IPCC, 2014b).

Climate change: Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the United Nations Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (United Nations, 1992). The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes (IPCC, 2014b).

Climate resilience: The capacity of a community, business, or natural environment to anticipate, prevent, withstand, respond to, and recover from a climate change related disruption or impact (Working Group on Adaptation and Climate Resilience, 2016).

Climate-related disaster: Potentially damaging climate-related physical hazard (drought, wildfire, etc.) that may affect physical, mental, spiritual, and cultural health and well-being, safety, property damage, social and economic interruption, or environmental degradation.

Community: The use of community throughout this report is dependent on the context of the chapter, objective, and/or indicator. The report itself identifies gaps around a consistent definition of community. Depending on context, community may refer to a theoretical group (professional communities, identity-based communities, etc.) or to geographically fixed populations (municipalities, local governments, etc.).

Critical infrastructure: The processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of Canadians and to the effective functioning of government (Public Safety Canada, 2012). Closely associated with the definition of basic services.

Culturally appropriate: Actions and frameworks for action that are respectful of each culture and/or community's context.

Directly affected: People who have suffered injury, illness or other health effects; who were evacuated, displaced, relocated; or have suffered direct damage to their livelihoods, economic, physical, social, cultural and environmental assets (UNISDR, 2017a).

Exposure: The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected (IPCC, 2014b).

First responder: In the context of this document, first responders are those who take action during climate-related events and who serve the needs of a broader community who may be at risk for physical and psychological harm. This definition extends beyond traditional definitions related to urban contexts (EMS, fire and police services) and includes operators of critical infrastructure and basic services, Emergency Management Organizations and their associated members, trusted messengers for vulnerable populations, as well as those individuals and institutions of community members acting in an emergency response capacity in northern, coastal, and remote regions.

Hazard: The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources (IPCC, 2014b). In this report, the term hazard usually refers to climate-related physical events or trends or their physical impacts.

Hazard area: Areas that are experiencing or are likely to experience climate-related hazards.

Indicators: A quantitative or qualitative factor or variable that provides a simple and reliable means to describe an issue that someone is concerned about, in a clear and understandable way, and track trends over time relative to a baseline (Briggs, 2002; OECD, 2002).

Indigenous Knowledge Systems: Cumulative, dynamic, and adaptive knowledge systems that are intertwined with personal, community, and national/cultural knowledge. Indigenous Knowledge Systems are a "way of being" that is broader than just specific ecological knowledge. Indigenous Knowledge Systems are heterogeneous, and are not narrow, static or historic; they continue to be applicable to policy and can support a more comprehensive understanding of climate change's social, economic, and environmental impacts.

Indirectly affected: People who have suffered consequences, other than or in addition to direct effects, over time due to disruption or changes in economy, critical infrastructure, basic services, commerce, work, or social, health and physiological consequences (UNISDR, 2017a).

Natural infrastructure: Naturally occurring or enhanced natural resources that provide adaptation or mitigation services to the gradual and/or sudden impacts of climate change or natural hazards. This definition includes naturally-occurring natural assets such as wetlands, forests, parks, lakes, rivers, creeks, fields and soil as well as Low Impact Development projects such as rain gardens, green roofs, permeable pavements, bioswales, absorbent landscapes, and rainwater harvesting.

Objectives: Concise statements of "what matters", usually consisting of the thing that matters and a verb that indicates the desired direction of change (Gregory et al., 2012).

Local Knowledge: The understandings, skills, and philosophies developed by communities with long histories of interaction with their natural surroundings. Adapted from UNESCO definition (UNESCO, 2017).

Rapid-onset event: Rapid onset events may be a single, discrete event that occurs in a matter of days or even hours (UNFCCC, 2012).

Resilience: The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation (IPCC, 2014b).

Risk: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability or likelihood of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur (IPCC, 2014b).

Slow-onset event: Slow-onset events evolve gradually from incremental changes occurring over many years or from an increased frequency or intensity of recurring events. This can include sea level rise, increasing temperatures, ocean acidification, glacial retreat and related impacts, salinization, land and forest degradation, loss of biodiversity, and desertification (UNFCCC, 2012).

Social capital: A measure of social cohesion, agency, trust, and social learning (Walker et al., 2014)

Vulnerability: In the context of climate change, vulnerability is the predisposition to be adversely affected by a change in climate, depending on sensitivity or susceptibility to harm, and capacity to cope and adapt (IPCC, 2014a). Vulnerability is a result of diverse historical, social, economic, political, cultural, institutional, natural resource, and environmental conditions and processes (IPCC, 2012).

Weather: The state of the atmosphere at a specific time. It is the short term or instantaneous variations of the atmosphere, as opposed to the long term, or climatic, changes (Environment and Climate Change Canada, 2018).

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Appendix I: Membership List

Chair	
Chair	Blair Feltmate, Ph.D., Intact Centre on Climate Adaptation
Indigenous Organizations and Governments	
Assembly of First Nations	Graeme Reed, Senior Policy Analyst
Inuvialuit Regional Corporation	Jennifer Parrott, Research Manager
Métis National Council	Kathy L. Hodgson-Smith, Senior Policy Advisor
Academia	
Simon Fraser University	Deborah Harford, Executive Director, ACT (Adaptation to Climate Change Team)
Ryerson University	Cory Searcy, Ph.D., P.Eng., Professor, Industrial Engineering & Environmental Applied Science and Management
Yukon College	Bronwyn Hancock, Associate Vice President, Research Development
University of New Brunswick	Louise Comeau, Ph.D., Research Associate and Instructor, Forestry and Environmental Management
Private Sector	
Insurance Bureau of Canada	Craig Stewart, Vice-President, Federal Affairs
Zizzo Strategy	Joanna Kyriazis, Policy Director
Engineers Canada	David Lapp, Manager, Globalization and Sustainable Development
Ontario Centre for Climate Impacts and Adaptation Resources	Al Douglas, Director
Capital Markets	
Mercer	Karen Lockridge, Principal, Responsible Investment
Last Spike Capital	Ian McPherson, Chief Executive Officer
Municipal	
City of Calgary	Twyla Kowalczyk, Water Resources Engineer
Federation of Canadian Municipalities	Sophie Pantin, Project Verification Specialist
ICLEI Canada—Local Governments for Sustainability	Ewa Jackson, Managing Director
Non-Governmental Organizations	
Credit Valley Conservation Authority and Conservation Ontario	Deborah Martin-Downs, Chief Administrative Officer

Fraser Basin Council	Bob Purdy, Director, External Relations and Corporate Development
Canadian Red Cross	Sarah Sargent, Vice-President, Canadian Operations Programs
Ouranos	Caroline Larrivée, interim Scientific Program Director
Youth Representative	
The Starfish Canada	Kyle Empringham, Co-Founder

Appendix II: Overview Table of Objectives and Indicators

Chapter 2: Protecting and Improving Human Health and Well-Being	
Objectives	**Indicators**
Objective 1: Reduce vulnerability by decreasing sensitivity to climate impacts through alleviating the conditions that make high-risk populations more vulnerable to health-related climate impacts	1. Proportion of climate change vulnerability assessments that consider high-risk populations (i.e., high risk populations as identified by the Canadian Red Cross)
	2. Percentage of Canadians living on low incomes in climate hazard areas
	3. Percentage of high-risk Canadians living in hazard areas with social support and response systems in place
Objective 2: Increase at-risk Canadians' ability to monitor and intervene to reduce their vulnerability to the health impacts of a climate-related hazard	4. Number of culturally appropriate public awareness and education campaigns to promote personal protection from climate change health effects
	5. Area covered by surveillance programs for water-, food- and vector-borne diseases
	6. Number of culturally-appropriate programs that identify mental health effects resulting from climate hazards
	7. Proportion of health care facilities that have emergency and management plans that include climate hazards (i.e., inclusion of on-site back-up energy sources, back-up water access, alternate access routes, emergency shelters, etc.)
Objective 3: Ensure adequate responses to health-related climate impacts for those for whom the climate hazard could not be eliminated	8. Number of health care practitioners trained to identify and respond to climate-related health effects (including doctors, nurses, social workers, first responders, pharmacists, etc.)
	9. Number of first responder support programs capable of addressing the physical and mental stresses associated with climate-related hazards
Chapter 3: Supporting Particularly Vulnerable Regions	
Objectives	**Indicators**
Objective 1: Increase northern, remote, and coastal regions' understanding of slow-onset events	10. Percentage of communities in northern, remote, and coastal areas with community-based, specialized (e.g., coastal erosion, permafrost thaw, etc.) environmental monitoring programs that incorporate climate/weather observations
	11. Percentage of population with access to local

	information on climate change, weather patterns, and associated impacts to regions and sectors in northern, remote, and coastal regions
	12. Percentage of communities and regions in northern, remote, and coastal areas with planning mechanisms that incorporate or consider climate risk and opportunities
Objective 2: Reduce the sensitivity of northern, remote, and coastal regions areas to slow-onset events	13. Number of key members of community (e.g., police, firefighters, water technicians, harvesters) with safety training and equipment to adapt to changing conditions
	14. Maximum response times in northern, remote, and coastal regions related to search & rescue and emergency response programming
	15. Percentage of people in northern, remote, and coastal communities whose access to the land, including country foods and traditional ways of life, is impacted by slow-onset events
	16. Number of funded initiatives directed at protecting cultural assets (e.g., archaeological/historical sites, spiritual sites, traditional foods/plants/medicines) located in vulnerable regions from climate risks
Objective 3: Increase the adaptive capacity of northern, remote, and coastal regions by providing the human, technical and financial resources to self-determine their response to slow-onset events	17. Percentage of northern, remote, and coastal communities with experienced and/or trained locals (including Elders with Indigenous Knowledge Systems) that are designing and implementing adaptation actions in their regions and/or communities
Objective 4: Improve regional collaboration between governments, communities, Indigenous Peoples, the private sector, and other relevant stakeholders (including agreements like MOUs and Data Sharing, which facilitate data access)	18. Number of adaptation initiatives and/or formal agreements (MOUs, etc.) that include a multi-stakeholder approach (governments, communities, Indigenous Peoples, private sector, and others) for regional planning
Chapter 4: Reducing Climate-Related Hazards and Disaster Risks	
Objectives	**Indicators**
Objective 1: Prevent and reduce exposure to hazards exacerbated by climate change while recognizing limitations of existing built environment	19. Percentage or number of communities with development and re-development 'build back better' control policies, bylaws and regulatory tools for climate-related hazards that are culturally appropriate and include Indigenous Knowledge Systems where appropriate
	20. Percentage or number of communities with climate-related hazard mapping incorporating climate change utilizing scientific information

	and, where appropriate, Indigenous Knowledge Systems
	21. Number of high-risk vulnerable populations in locally identified high-risk climate hazard areas (not accounting for defenses)
	22. Number of properties (residential and businesses) in climate adjusted river and shoreline flood hazard areas (not accounting for defenses)
	23. Number of watershed or regional-scale water management plans incorporating future water supply due to climate change
Objective 2: Increase preparedness for emergency response to hazards exacerbated by climate change involving high-risk vulnerable population representatives	24. Percentage or number of communities that have developed or updated emergency response plans that consider future climate-related hazard extremes
	25. Percentage or number of emergency management organizations that have representatives of local and/or regional high-risk vulnerable populations that participate in prioritization and decision-making
	26. Number of hours of climate-related disaster response training and exercises
	27. Percentage or number of culturally and locally relevant emergency response warning systems focusing on high-risk vulnerable populations
Objective 3: Improve the efficiency and equity of emergency response to future climate-related hazard events	28. Average speed of emergency response to an event focused on high-risk vulnerable populations
	29. Number of people directly affected by a climate-related disaster
Objective 4: Improve efficiency and resilience during recovery following climate-related hazard events	30. Number of days for citizens to receive financial assistance (cash-in-hand) from time of application
	31. Percentage of total financial losses restored, making citizens whole
Chapter 5: Building Climate Resilience through Infrastructure	
Objectives	**Indicators**
Objective 1: Integrate climate resilience into policies, bylaws, plans and other planning mechanisms that direct development, affect safety, determine placement of infrastructure and consider interdependencies	32. Percentage of communities (regional, municipal, Indigenous Peoples) with planning mechanisms that incorporate or consider climate resilience in community infrastructure development
	33. Number of codes and standards reviewed, updated and developed across the full breadth of climate hazard types and asset

	types at risk, including Indigenous-specific building programs
	34. Number of government procurement documents integrating climate resilience considerations into their requirements and specifications for infrastructure
	35. Number of critical infrastructure in locally identified high-risk climate hazard areas
Objective 2: Integrate climate resilience into infrastructure investments	36. Number of Canadian institutional investors that have integrated climate change adaptation or resilience considerations into their investment strategies
	37. Percentage of total government infrastructure spending directed to building resilience towards locally-identified high priority climate risks (as identified by community climate vulnerability assessments)
	38. Amount of investment ($) directed to critical and climate resilient infrastructure (as defined by the recipient community) for Indigenous Peoples, including telecommunications, transportation and energy infrastructure
Objective 3: Protect and enhance natural and cultural assets and better integrate them into design, planning and investment decisions to enhance community and ecosystem resilience	39. Percentage of total government infrastructure spending directed towards natural infrastructure
	40. Percentage of communities (regional, municipal, Indigenous Peoples) that have natural and cultural asset management plans
Objective 4: Maintain or improve levels of infrastructure services considering a changing climate	41. Number of days of disruption to basic services and critical infrastructure
	42. Number of infrastructure operation and maintenance plans that have integrated climate resilience considerations
	43. Number of infrastructure owners and operators that have integrated climate resilience into their planning, infrastructure investments, operations and strategy
Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action	
Objectives	**Indicators**
Objective 1: Indigenous Knowledge and science systems are invested in and respectfully utilized equally and/or together for adaptation knowledge production	44. Number of community-based climate-related monitoring and adaptation programs that include Indigenous, local and scientific knowledge
	45. Amount of federal, territorial/provincial or municipal funds invested in development of up to date, accessible, relevant, co-produced,

	localized, equitably distributed information on climate and environmental data for both regions and sectors that can be used to support planning and decision making
	46. Number of adaptation-related research, knowledge and action materials and resources developed across themes and sectors for climate change
	47. Number of codes and standards developed that refer to, or address climate change and adaptation
Objective 2: Canadian individuals and organizations have increased capacity for participation in adaptation	48. Number of training or capacity building programs that demonstrate the application of Indigenous Knowledge Systems and/or scientific information in the context of climate change adaptation
	49. Percentage of Canadian professionals across sectors who have training in adaptation
Objective 3: Climate change adaptation knowledge developed using the approaches outlined in Objectives 1 and 2 is being translated into action and implemented in plans and practices at multiple levels and scales	50. Extent of each province and territory covered by adaptation plans incorporating climate risk assessments, designed to be updated every 5 years
	51. Percentage of communities (including youth) implementing actions that support adaptation or increase resilience
	52. Number of federal and territorial/provincial cumulative risk assessments and other environmental assessments that incorporate projections of future climate
	53. Percentage of property/casualty insurance policies that incent adaptation
	54. Percentage of federal, provincial, territorial, and municipal or non-governmental organization funding allocated to implementation of adaptation actions

Appendix III: Indicator Templates

The following pages include templates for all the indicators recommended by the Expert Panel. The templates provide additional details on the recommended indicator, including the rationale, contextual and baseline information, information on the relevance of the proposed indicator for Indigenous Peoples, and other key details.

The details contained in the templates may be of particular interest or use to those seeking to learn more about or measure the proposed indicators. However, the indicator templates were prepared by different Expert Panel members with varying research capacities, and further research and analytical work would be needed to fully explore and identify, for instance, all possible data sources and limitations of the proposed indicator. As such, the information contained in the indicator templates should be considered preliminary.

Protecting and Improving Human Health and Well-Being

1. Proportion of climate change vulnerability assessments that consider high-risk populations (i.e., high risk populations as identified by the Canadian Red Cross)

FACTORS TO CONSIDER	
RATIONALE	To effectively prepare for the health impacts of climate change, Canadian public health and emergency management officials from local to national levels require: • Information about the risks posed by current climate variability; • The possible impacts associated with future climate change; • The unique vulnerabilities facing specific populations, communities or regions; and • Effective measures to protect health. Climate change and health vulnerability and adaptation assessments provide this information to support health authorities in preparing for threats both familiar, which may present themselves at an increased frequency and/or severity (e.g., flooding, drought, extreme heat, vector-borne disease, air pollution, wildfires), and unfamiliar, which may impact both individuals and health systems (e.g., exotic infectious diseases, catastrophic impacts from multiple events).
METRIC USED	Number of climate change and health vulnerability and adaptation assessments completed by local public health units, provincial/territorial ministries of health, and federal health agencies that include an examination of vulnerabilities and possible adaptation measures related to populations deemed or found to be high-risk from climate change impacts on health, within a specific jurisdiction (e.g., seniors, Indigenous Peoples, low-income residents, persons with low literacy levels, transient populations, persons with a disability, medically dependent persons, children and youth, women, new immigrants, and cultural minorities).
BASELINE	Current number of completed climate change and health vulnerability and adaptation assessments
CONTEXTUAL INFORMATION	The World Health Organization, Health Canada, and the Ontario Ministry of Health and Long Term Care recommend that health authorities undertake climate change and health vulnerability and adaptation assessments and provide guidance for doing so (WHO, 2012; MOHLTC, 2016). Completing an assessment will support health authorities in identifying and interpreting the information needed to prepare their health systems for the impacts of climate change. The information developed serves to: • Identify resources and assess knowledge leading to a better understanding of the relationship between weather/climate and health outcomes; • Provide information on the expected distribution and severity of future climate change and health impacts to health and emergency management officials, stakeholders and the public – including expected impacts on high risk populations; • Identify opportunities and options for incorporating information on the health impacts of climate change into existing policies and programs or, where needed, into the formation of new policies and programs to either

	reduce or prevent the health impacts of climate change; • Provide a baseline of information against which future changes in health risks related to climate change and the effectiveness of associated policies and programs may be measured; and • Facilitate the development of inter-sectoral relationships and collaborations with the goal of protecting and improving health (e.g., collaborate with land-use planners to reduce the urban heat island effect). Population level vulnerabilities to climate change impacts are influenced not only by biological factors but also social and environmental factors such as employment, education, housing, culture, gender, physical environment, and income. Effective measures to protect populations of concern need to consider and address social and environmental factors that influence health outcomes in order for all people to have the opportunity to experience their highest level of health.
RELEVANCE FOR INDIGENOUS PEOPLES	Climate change and health vulnerability and adaptation assessments are properly undertaken through a participatory approach that includes respectful engagement and involvement of Indigenous Peoples and other partners in all steps of the project. They are developed with full consideration of Indigenous Knowledge of climate change impacts on health in the respective jurisdiction and of adaptation measures that most effectively and equitably reduce current and future health burdens. Due to both long-seeded systemic inequalities and changing environmental conditions, many Indigenous Peoples, particularly those in northern and remote locations, are experiencing disproportionate health risks from climate change. Indigenous Knowledge Systems can be a critical source of information for understanding and communicating risks to health from climate change in Canadian communities and therefore a critical input toward the development of effective adaptation measures through climate change and health vulnerability and adaptation assessments, or otherwise. Indigenous Knowledge Systems represent countless generations of insight into the connectivity of human and planetary health that has been inherited by the Indigenous Peoples of today. First Nations and Inuit communities may use assessments, or similar projects, to prepare for climate change or may use other planning mechanisms to bring Indigenous Knowledge Systems and local knowledge to the attention of community leaders, to inform climate change and health adaptation efforts. Consequently this indicator may be less applicable for measuring progress related to addressing health risks from climate change facing Indigenous Peoples.
LIMITATIONS	Important limitations face health authorities in Canada that may wish to use this indicator. Currently, few jurisdictions in Canada (Ontario being an exception) require health authorities to conduct climate change and health vulnerability and adaptation assessments and therefore, institutional mechanisms to monitor this indicator do not exist. Consequently baseline information about the number of assessments that have been undertaken is not available. However, the new Health Canada

	"Climate Change and Health Adaptation Capacity Building Multi-Year Pilot Program" will develop mechanisms (e.g., Community of Practice on Climate Change and Health Assessments) that may provide the opportunity for obtaining information relevant to this indicator. Comprehensive climate change and health vulnerability assessments include steps for identifying priority climate change and health adaptation options, developing an adaptation plan, and monitoring and evaluating progress towards reducing health burdens related to climate change. However, this indicator is not and should not be used as a direct measure of climate change and health adaptation given that assessments inform the eventual implementation of such actions but do not document it.
OVERLAP WITH OTHER CHAPTERS	This indicator would provide information that is complementary to, or would integrate information from, indicators developed in Chapter 3: Supporting Particularly Vulnerable Regions and Chapter 4: Reducing Climate-Related Hazards and Disaster Risks.
POTENTIAL DATA SOURCES	Local, provincial, territorial, and national health authorities
REFERENCES/MORE INFORMATION	Examples of national and local climate change and health vulnerability and adaptation assessments include: Berry, P., Clarke, K-L., Fleury, M.D., and Parker, S. Human Health. In Warren, F.J. and Lemmen, D.S, editors (2014): *Canada in a changing climate: Sector perspectives on impacts and adaptation*. Government of Canada, Ottawa, ON. http://www.nrcan.gc.ca/environment/resources/publications/impacts-adaptation/reports/assessments/2014/16309 Berry, P., Paterson, J., and Buse, C., (2014). *Assessment of vulnerability to the health impacts of climate change in Middlesex- London*. Report Prepared for the Middlesex-London Health Unit. London. https://www.healthunit.com/climate-change Examples of Canadian and international guidance for conducting climate change and health vulnerability and adaptation assessments, including monitoring progress toward reducing climate-related health burdens include the following: Ebi, K.L., Berry, P., Campbell- Lendrum, D., et al., (2012). *Protecting health from climate change: Vulnerability and adaptation assessment*. World Health Organization and Pan American Health Organization, Geneva. http://www.who.int/globalchange/publications/Final_Climate_Change.pdf Ebi, K., Paterson, J., Yusa A., Anderson, V., and Berry, P. (2016). *Climate Change and Health Vulnerability Assessment Guidelines for the Province of Ontario*. Report Developed for the Ministry of Health and Long-term Care, Toronto.

2. Percentage of Canadians living on low incomes in climate hazard areas

FACTORS TO CONSIDER	
RATIONALE	Vulnerability to health-related climate change impacts is, to a great degree, socially determined. In particular, income and social status influence individual and community capacity to adapt to climate impacts. When hit by climate hazards, people afflicted by poverty suffer great losses in terms of lives and livelihoods. The inequitable impact of climate hazards further aggravates existing socioeconomic inequalities and undermines the capacity of people to cope and adapt.
METRIC USED	Number of people
BASELINE	Median household income Climate hazard risk maps (e.g., flooding, wildfire, storm surge, etc.) Low-income households - Statistics Canada calculates low income using the after-tax low-income measure (LIM) for individuals. Individuals are defined as having low income if the after-tax income of their household falls below half of the median adjusted household after-tax income. Adjusted household income is calculated using the income of a household divided by the square root of the household size. The median income is the amount that divides the income size distribution into two equal parts (Statistics Canada, 2016 Census of Population).
CONTEXTUAL INFORMATION	To effectively apply this indicator users must have a geo-spatial understanding of risk using mapping or modelling, layering onto a census, or other data related to household or individual income.
RELEVANCE FOR INDIGENOUS PEOPLES	The 2016 Census of Population figures for areas identified as Indigenous communities found approximately 81 per cent of reserves had median incomes below the low-income measure, which Statistics Canada considers to be $22,133 per year for one person (Statistics Canada, Census of Population, 2016). Impacts associated with climate change, particularly those related to extreme weather, are felt differently by different social groups. For example, a lack of adequate and affordable housing for Indigenous Peoples (Statistics Canada, Census of Population, 2016) leads to an increase in social vulnerability as families are forced to live in housing that is older and in poor condition without the financial means to prepare for climate impacts.
LIMITATIONS	The use of this indicator requires an understanding of the relationship between climate change and social vulnerability, particularly the influence of income on an individual's or household's capacity to adapt to climate change impacts.
OVERLAP WITH OTHER CHAPTERS	As this indicator is most valuable in looking at the vulnerability of low-income Canadians to climate impacts, it can be used to measure improvements in adaptive capacity with regard to disaster risk reduction.
POTENTIAL DATA SOURCES	Statistics Canada census data
REFERENCES/MORE INFORMATION	

3. Percentage of high-risk Canadians living in hazard areas with social support and response systems in place

FACTORS TO CONSIDER	
RATIONALE	Social capital plays a critical role during disasters and extreme weather events, such as those posed by climate change. High levels of social capital can help residents survive climate-related disasters and accelerate recovery and long-term adaptation. Social capital motivates residents to return to damaged areas and to petition political leaders for assistance in handling challenges (Aldrich, 2010). Individuals with strong social ties to neighbours, feelings of attachment and place, and a vision for their neighborhood's future are more likely to return and restore a damaged neighborhood (Aldrich, Page, & Paul, 2016)
METRIC USED	Number of high-risk Canadians living in at risk areas with a demonstrated level of social support relative to the total number of high-risk Canadians living in at risk areas.
BASELINE	Three datasets are required to establish an effective baseline: • Climate risk mapping; • Identification of high-risk Canadians; and • Demonstration of social support levels.
CONTEXTUAL INFORMATION	Social capital is a measure of social support, cohesion, and trust. Improving health and well-being by increasing social capital and decreasing social isolation is a crucial adaptation strategy that can minimize the health impacts of climate change. Having a social support and response system can reduce exposure to health-related climate impacts, including those experienced during and after extreme events. Social capital adds to the understanding of community-level factors that impact health, and numerous institutions support consideration of social capital as a health determinant, for instance by influencing health-related behaviours and access to services and amenities, and by affecting psychosocial processes between individuals and groups (Mignone, Elias, & Hall, 2011).
RELEVANCE FOR INDIGENOUS PEOPLES	One study of social capital in First Nations communities looked at culture stress factors or "the loss of confidence by individuals or groups in the ways of understanding life and the norms, values and beliefs that were taught to them within their original culture(s), and the personal or collective distress that may result" as a particularly unique loss of social capital (Mignone et al., 2011). This includes loss of control over land and living conditions, breakdown of cultural values and belief systems, loss of identity and self-esteem, and discrimination. The resurgence of Indigenous ceremonies, practices, and values has already shown powerful healing qualities, all of which requires community investment (Mignone et al., 2011).
LIMITATIONS	A notable challenge associated with the use of this indicator is gathering the baseline data required to effectively track progress against this indicator. Three unique datasets are required: climate risk mapping, identification of high-risk Canadians, and demonstration of social support levels. As a result, reliable baseline data may be difficult to acquire.
OVERLAP WITH	This indicator is most valuable in measuring the vulnerability of at-risk Canadians

OTHER CHAPTERS	to climate impacts through investigation into their levels of social support. As such it can be used to measure improvements in adaptive capacity with regard to disaster risk reduction.
POTENTIAL DATA SOURCES	To be tracked at the national level this indicator would need to be aligned with the Statistics Canada General Social Survey and the relevant variables within used to track social capital: • Frequency of in-person contact with friends of person, category • Frequency of in-person contact with relatives of person, category • Number of acquaintances of person, category • Number of close friends of person, category • Number of relatives to whom person feels close, category At the local or community level this indicator could be tracked through public health units, community programming partners, or local governments.
REFERENCES/MORE INFORMATION	Statistics Canada General Social Survey (2003, 2008, 2013) done every five years http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SurvId=134876&InstaId=139605&SDDS=5024 Aldrich, D. P. (2010). Fixing Recovery: Social Capital in Post-Crisis Resilience. *Journal of Homeland Security*, *6*, 1–10. Mignone, J., Elias, B., Hall, M. (2011). Validation of a Culturally Appropriate Social Capital Framework to Explore Health Conditions in Canadian First Nations Communities. *The International Indigenous Policy Journal*, 2(1). Retrieved from: http://ir.lib.uwo.ca/iipj/vol2/iss1/3

4. Number of culturally appropriate public awareness and education campaigns to promote personal protection from climate change health effects

FACTORS TO CONSIDER	
RATIONALE	Personal preparedness against climate change health effects is an important component of health promotion. Irrespective of the actions taken by local, sub-national, and national governments, individuals will need to take actions to promote their personal protection from climate change health effects.
METRIC USED	Number of programs
BASELINE	To use this indicator, organizations must investigate the number of programs that promote personal protection and determine whether in the given context of use they can be considered as culturally appropriate.
CONTEXTUAL INFORMATION	Despite its direct impact on human health, climate change is typically discussed and reported on as an environmental or infrastructure problem. As a result, most Canadians think of the physical environment (e.g., roads, pipes, glaciers and polar ice caps) and non-human species (e.g., plants and polar bears) as being the primary victims of the worst effects of climate change. They perceive its human impacts as being distant, experienced somewhere else, and at some time in the future. Resulting from this (mis)communication, Canadians have not taken effective measures to protect themselves from health-related climate impacts.
RELEVANCE FOR INDIGENOUS PEOPLES	In many cases across Canada, Indigenous Peoples are facing climate change driven health impacts that are disproportionate in both their frequency and severity. Compounding these consequences is that in many communities Indigenous Peoples do not have access to the resources or capacities needed to adequately prepare or respond to the climate impacts.
LIMITATIONS	The limitations and challenges of tracking the number of culturally-appropriate programs that identify mental health effects resulting from climate risks may include the following: • Challenges of defining 'culture' and 'culturally appropriate' (e.g., who defines what is culturally appropriate?) • The data required to establish a baseline is currently not collected • The number of programs that could fall under this indicator could change drastically from year-to-year; it may be more appropriate to look at the ratio change relative to this indicator.
OVERLAP WITH OTHER CHAPTERS	Programs to support personal level protection to climate impacts are needed to further action across the country. Therefore the intent of this indicator overlaps with the objectives of Chapter 3: Supporting Particularly Vulnerable Regions, Chapter 4: Reducing Climate-Related Hazards and Disaster Risks, and Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action.
POTENTIAL DATA SOURCES	Individual Health Authorities Public Health Agency of Canada Individual surveys of social service agencies
REFERENCES/MORE INFORMATION	

5. Area covered by surveillance programs for water-, food- and vector-borne diseases

FACTORS TO CONSIDER	
RATIONALE	Climate change threatens to increase the health threats posed by water-, food-, and vector-borne diseases. In some areas of Canada new health threats, such as Lyme disease (a vector-borne disease), are impacting the health of Canadians. This indicator assesses the area of Canada currently covered by surveillance programs designed to identify health risks associated with climate change impacts on water-, food-, and vector-borne diseases.
METRIC USED	Proportion of Canada covered by surveillance programs for water-, food- and vector-borne diseases that can be associated with a changing climate. These surveillance programs may be operated in whole by one agency or in partnership with other health actors (in some cases this includes international partners) and may be coordinated by federal, provincial/territorial, local/regional and Indigenous governments, organizations or health authorities.
BASELINE	Establishing the baseline for this indicator will require an analysis of all federal, provincial/territorial, and local/regional surveillance systems to identify what proportion of Canada's area is currently served by a surveillance program for water-, food-, and vector-borne diseases that can be associated with climate change.
CONTEXTUAL INFORMATION	Surveillance programs are at their core pre-established systems for the ongoing collection, interpretation, and dissemination of data on disease and disease agents. Effective surveillance is often considered the foundation of public health systems and a key component of evidence-based health decision-making. Adapting or expanding surveillance programs to better incorporate the surveillance of the health threats associated with climate change has consistently been identified as a priority action for Canada's health sector. Ensuring that health decision-makers and practitioners have access to reliable and timely information is essential to ensuring the provision of effective health care at both local and national scales. Assessing the extent of Canada's surveillance systems for water-, food-, and vector-borne diseases may provide insight into Canada's progress towards adapting surveillance systems to meet the challenges posed by climate change. Due to efforts to increase surveillance for emerging health threats, public health professionals are in a better position to plan for and respond to the health impacts of climate change. Enhancing surveillance for possible climate change related health impacts associated with water-, food-, and vector-borne diseases should improve the capacity of health decision-makers to work to protect the health of Canadians.
RELEVANCE FOR INDIGENOUS PEOPLES	Due to both geography and cultural ties to the land many Indigenous Peoples are at the forefront of emerging health impacts related to climate change. For this reason, understanding the extent of Canada's climate relevant surveillance programs, specifically those for water-, food-, and vector-borne diseases, will be

	of direct relevance to Indigenous Peoples. Indigenous Peoples and Indigenous organizations and governments are key partners in some existing surveillance programs. Such partnerships will be invaluable in moving forward with the development of surveillance programs targeted at the health impacts of climate change, such as those related to water-, food-, and vector-borne diseases.
LIMITATIONS	Effective surveillance programs are an essential element of climate resilient health systems. However, utilizing the proposed indicator as a measure of Canada's adaptation to climate change may face some difficulties, including: • The area covered by surveillance systems may not accurately illustrate the effectiveness of those systems; • The health threats under surveillance may not be exhaustive and surveillance systems may vary from jurisdiction to jurisdiction; • The area covered by surveillance systems may not necessarily represent a direct adaptation to climate change; and • Canada's population is already covered by surveillance systems for water-, food-, and vector-borne diseases – there is a need to apply more targeted adaptations to surveillance systems with the aim of observing specific emerging health threats.
OVERLAP WITH OTHER CHAPTERS	Surveillance systems serve to provide much needed information to health care decision-makers across the country. Therefore the intent of this indicator overlaps with the objectives of Chapter 3: Supporting Particularly Vulnerable Regions and Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action
POTENTIAL DATA SOURCES	Canada has an extensive network of health surveillance systems operated at various jurisdictional levels that could provide valuable data. Some examples include: • Federally coordinated national surveillance systems (including surveillance on various climate sensitive health outcomes including many water-, food- and vector-borne diseases) • Provincially coordinated surveillance systems • Local or regional surveillance systems (e.g., these may include surveillance done by public health authorities, by hospital networks, etc.)
REFERENCES/MORE INFORMATION	Below are resources that highlight the value of enhanced surveillance as an adaptation to the health impacts of climate change as well as examples of existing surveillance systems which may be used to establish the baseline status of the proposed indicator: Ogden, Nick H., and L. Robbin Lindsay. "Effects of climate and climate change on vectors and vector-borne diseases: ticks are different." *Trends in parasitology* 32, no. 8 (2016): 646-656. Ripoche, Marion, Salima Gasmi, Ariane Adam-Poupart, Jules K. Koffi, L. Robbin Lindsay, Antoinette Ludwig, François Milord, Nicholas H. Ogden, Karine Thivierge, and Patrick A. Leighton. Passive Tick Surveillance Provides an Accurate Early Signal of Emerging Lyme Disease Risk and Human Cases in Southern

	Canada. *Journal of Medical Entomology* XX(X) (2018). Berry, P., Clarke, K.L., Fleury, M., Parker, S (2014). Chapter 7: Human health. In Warren, F.J. and Lemmen, D.S., editors (2014): *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*. Government of Canada. Public Health Agency of Canada. 2018. Public Health Surveillance. https://www.canada.ca/en/public-health/services/surveillance.html. • This resource includes information on 27 federally coordinated surveillance programs including some with direct relevance to the proposed indicator (e.g., FoodNet Canada, the Lyme Disease Enhanced Surveillance System, West Nile Virus Surveillance Information, etc.) Nichols, Gordon L., Yvonne Andersson, Elisabet Lindgren, Isabelle Devaux, and Jan C. Semenza. "European monitoring systems and data for assessing environmental and climate impacts on human infectious diseases." *International journal of environmental research and public health* 11, no. 4 (2014): 3894-3936.

6. Number of culturally-appropriate programs that identify mental health effects resulting from climate hazards

FACTORS TO CONSIDER	
RATIONALE	This indicator documents the number of culturally-appropriate programs that identify mental health effects resulting from climate risks. The rationale for documenting this indicator is to understand the risks, vulnerabilities, and impacts of climate change on mental health and to reduce the mental health effects of climate change. Documenting this indicator supports an equity-focused approach to building resilience to the mental health impacts of climate change .
METRIC USED	There are a number of possible quantitative and qualitative metrics exist to measure this indicator, these metrics include: Quantitative: • Number of mental health programs in Canada • Number of mental health programs in Canada that are culturally-appropriate • Number of mental health programs in Canada that identify climate change risks to mental health • Number of mental health programs that are culturally-appropriate AND identify mental health effects resulting from climate change Qualitative: • Focus groups with a sample of Indigenous Peoples (First Nations, Inuit, Métis) about their perceptions of, and experiences with, culturally-appropriate programs that identify the mental health effects resulting from climate change. • Focus groups with people who are most vulnerable to the mental health effects of climate change and self-identify as one or more of the following: women, seniors, people with pre-existing conditions. Explore their perceptions of, and experiences with, culturally-appropriate programs that identify the mental health effects resulting from climate change. • Focus groups with mental health care providers about their perceptions of delivering culturally-appropriate programs that identify the mental health effects resulting from climate change.
BASELINE	In order to measure this indicator, the baseline information required includes: • Definition of 'mental health programs', 'culturally-appropriate', 'climate change risks to mental health' • Current number of mental health programs in Canada • Current number of mental health programs in Canada that are culturally-appropriate • Current number of mental health programs in Canada that identify climate change risks to mental health
CONTEXTUAL INFORMATION	Evidence from the last Canadian climate change and health assessment suggests that Canadians can be at risk of mental health and stress-related illness associated with extreme weather events, such as flooding or heat waves (Berry et al., 2014). Adaptation actions that support mental health, such as mapping of mental health care assets, can be effective in supporting mental health and well-being.

	• Mental Health Programs: ○ Mental health programs include all mental health care programs governed by municipal, provincial, territorial, Indigenous, tribal, federal health authorities. ○ Mental health programs include any form of public health programs aimed at treating mental health impacts resulting from climate events • Culturally Appropriate Programs: ○ Culturally-appropriate programs refer to programs that specifically aim to support mental health and well-being via mental health care that is culturally relevant, culturally respectful, and delivered from a space of cultural humility. For example, mental health care that embeds Indigenous Knowledge Systems and practices and care-providers that deliver mental health care that is culturally respectful and culturally relevant would be considered a culturally-appropriate program. **Population features of populations that are most impacted by the mental health consequences of climate change:** gender and sex; race and ethnicity; age; people with pre-existing conditions; people who are unemployed or underemployed; people who are undereducated; people who are socially isolated; people with low socio-economic status; occupational groups (e.g., outdoor labourers and first responders); minority linguistic communities; rural, urban, and suburban communities; people who are underinsured or uninsured; people who live in high-risk geographic environments; newcomers to Canada; Indigenous Peoples.
RELEVANCE FOR INDIGENOUS PEOPLES	The mental health implications of climate change disproportionally affect Indigenous Peoples; thus, Indigenous Knowledge Systems are a particularly integral component of measuring against this indictor. This indicator can be used in the context of documenting culturally-appropriate mental health programs by and for Indigenous Peoples.
LIMITATIONS	The limitations and challenges of tracking the number of culturally-appropriate programs that identify mental health effects resulting from climate risks may include the following: • Challenges of defining 'culture' and 'culturally appropriate' (e.g. who defines what is culturally appropriate?) • The climate change effects on mental health are generally not well-understood, which makes it difficult to establish baseline data on the number of mental health programs in Canada that identify climate change risks to mental health. • Focus group session will require human resources for facilitation and data analysis and will also likely require financial honorariums for participants. • The mental health effects of climate change are broad and wide-ranging making it difficult to track and monitor this indicator. The timing of climate change-related impacts to mental health varies - from immediate impacts, to mid-term (months), to long-term (years). Further, attributing climate change to mental health is challenging because there are a whole host of social determinants of health at play to amplify the mental health implications

	related to climate change hazards. - This indicator does not assess the effectiveness of culturally appropriate programs that identify mental health effects of climate change – the indicator only aims to establish the number of culturally appropriate programs. To understand effectiveness, interviews with program-users are required.
OVERLAP WITH OTHER CHAPTERS	This indicator would provide information that is complementary to, or would integrate information from, indicators developed in Chapter 2: Protecting and Improving Human Health and Well-Being and Chapter 3: Supporting Particularly Vulnerable Regions
POTENTIAL DATA SOURCES	- Mental health Commission of Canada (MHCC) - Municipal, provincial, territorial, Indigenous Peoples health services
REFERENCES/MORE INFORMATION	Below are resources that highlight the mental health risks of climate change and adaptation opportunities: Berry, P., Clarke, K.L., Fleury, M., Parker, S (2014). Chapter 7: Human health. In Warren, F.J. and Lemmen, D.S., editors (2014): *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*. Government of Canada, Ottawa, ON, 286p. Berry, H. L., Bowen, K., & Kjellstrom, T. (2010). Climate change and mental health: A causal pathways framework. *International Journal of Public Health*, 55, 123–132. Fritze, J. G., Blashki, G. A., Burke, S., and Wiseman, J. (2008). Hope, despair and transformation: Climate change and the promotion of mental health and wellbeing. *International Journal of Mental Health Systems*, 2, 1–13. Clayton, S., Manning, C. M., Krygsman, K., and Speiser, M. (2017). *Mental Health and Our Changing Climate: Impacts, Implications, and Guidance*. Washington, D.C.: American Psychological Association, and ecoAmerica Cunsolo Willox, A. , Harper, S. L., Ford, J. D., Edge, V. L., Landman, K., Houle, K., Blake, S., and Wolfrey, C. (2013b). Climate change and mental health: an exploratory case study from Rigolet, Nunatsiavut, Canada. *Climatic Change*, 121(2), 255-270. Dodgen, D., D. Donato, N. Kelly, A. La Greca, J. Morganstein, J. Reser, J. Ruzek, S. Schweitzer, M.M. Shimamoto, K. Thigpen Tart, and R. Ursano, 2016: Ch. 8: Mental Health and Well-Being. *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment*. U.S. Global Change Research Program, Washington, DC, 217– 246. http://dx.doi.org/10.7930/J0TX3C9H Weissbecker, I. (2011). Climate change and human well-being. *Springer Fachmedien*.

7. Proportion of health care facilities that have emergency and management plans that include climate hazards (i.e., inclusion of on-site back-up energy sources, back-up water access, alternate access routes, emergency shelters etc.)

FACTORS TO CONSIDER	
RATIONALE	Health care facilities can reduce risks of climate change through proper management of critical resources (e.g., pharmaceuticals, food, transportation, medical supplies and equipment) vis-à-vis emergency plans that include climate change risks.
METRIC USED	Number of health care facilities that have emergency plans that include climate risks relative to the total number of health care facilities.
BASELINE	The total number of health care facilities. Health care facilities include hospitals, clinics (physician, social services, nursing), outpatient care centers, and specialized care centers, such as birthing centers and psychiatric care centers.
CONTEXTUAL INFORMATION	Climate change poses risks to health care facilities in the same way it does to any other institution or business (e.g., operational disruption, physical damage, service interruption, etc.). For example, extreme weather can damage hospital infrastructure, disrupt power supplies, compromise the availability of critical resources and place greater demands on health care staff and affect patient safety. Health care facilities can manage these risks in part through effective emergency response and/or management plans that incorporate climate change considerations within them. These plans should be tested and revised in regular intervals to inform stakeholders and consider the latest climate information, building systems, and operational activities.
RELEVANCE FOR INDIGENOUS PEOPLES	Of particular reference for Indigenous Peoples, as well as northern and remote communities will be considerations of culturally appropriate health care systems, such as culture, community relations, and spirituality as core determinants of individual, community, and land health. In the context of this indicator the inclusion of non-medical facilities as health care centres, such as community centres, spiritual hubs, schools, etc. is important.
LIMITATIONS	Data collection may be challenging relative to this indicator as a comprehensive list of all health care facilities (using a broad definition of health care) may not be available. This could be overcome by collecting this data at a community scale whereby local stakeholders identify appropriate facilities and survey the existence of emergency plans.
OVERLAP WITH OTHER CHAPTERS	This indicator looks at the preparedness aspect of disaster risk reduction. Progress made on this indicator should be included when measuring progress on disaster risk reduction planning. As such this indicator overlaps with the preparedness objective within Chapter 4: Reducing Climate-Related Hazards and Disaster Risks.
POTENTIAL DATA SOURCES	Provincial Ministries of Health • Some provincial health ministries have Health Emergency Management sections that have emergency coordinators who are responsible for hospital emergency plans. ○ Could survey provincial/territorial Health Ministry Emergency

	Management sections
	- Hospital Insurance organizations
	  ○ Many hospital insurance organizations have risk management programs, which could require this as part of their insurance coverage.
	- Canadian Institute for Health Information
	  ○ Information related to institutional emergency and management plans could be added to this index
	- Individual surveys of health care facilities (e.g., hospitals, nursing clinics, counselling centres, etc.)

REFERENCES/MORE INFORMATION	Health Care Facility Climate Change Resiliency Checklist (http://www.greenhealthcare.ca/climateresilienthealthcare/CCGHC-HealthCareFacilityResiliencyChecklist.pdf)

8. Number of health care practitioners trained to identify and respond to climate-related health effects (including doctors, nurses, social workers, first responders, pharmacists, etc.)

FACTORS TO CONSIDER	
RATIONALE	Across Canada climate change is increasing direct and indirect health risks to Canadians. Gradual warming of the climate and more severe and frequent extreme weather events can result in the emergence of new health risks and the exacerbation of existing ones in communities across Canada. This means that health care professionals (doctors, nurses, social workers, first responders, pharmacists, etc.) should be properly trained to identify these threats in order to protect the health and wellbeing of Canadians. This indicator documents progress towards equipping the health workforce with the skills needed to protect Canadians from the health impacts of climate change.
METRIC USED	Number of health care practitioners trained to identify and treat climate change health effects.
BASELINE	The current baseline status of the number of health care practitioners trained to identify climate change health effects can be established through a survey administered in partnership with the relevant professional colleges, associations and providers of post-secondary education.
CONTEXTUAL INFORMATION	Climate change is increasing health risks to Canadians including by increasing morbidity and mortality in relation to extreme weather events (including extreme heat, flooding, drought, ice storms, hurricanes, etc.), increased indoor and ambient air pollution, increased exposure to ultraviolet radiation, reduced water quality, increased threats to food security and safety, impacts to mental health (e.g., in survivors of natural disasters) and the spread of vectors associated with emerging infectious diseases. Climate change is also increasing pressures on health systems that function to protect and maintain the health of Canadians, including by driving increased demand for health services and by increasing the risk that health services may be disrupted by climate change related events (e.g., increased risk that health care facilities may be impacted by an extreme weather event). To prepare health care practitioners for climate change, training programs should be developed to provide them with the knowledge and skills needed to understand climate change related health impacts, diagnose and treat patients and give them advice on preventative measures they can take to protect themselves and their families. Such programs can be targeted to new professionals completing their foundational training (e.g., medical students) as well as to mid-career professionals who may need enhanced training regarding how climate change may impact the health of their patients.
RELEVANCE FOR INDIGENOUS PEOPLES	In many cases across Canada Indigenous Peoples are facing climate change driven health impacts that are disproportionate in both their frequency and severity. Those responsible for providing health care to Indigenous Peoples must have the proper training to recognize the health impacts of climate change and to provide effective care in a culturally-appropriate manner. This will require Indigenous

	Peoples to be included as equal partners in the development of training curricula and to respectfully, meaningfully, and equitably include Indigenous Knowledge Systems into training programs and patient care practices.
LIMITATIONS	Though the need to provide training to health care practitioners is evident there may be some limitations to using this indicator as a measure of Canada's adaptation to climate change. These limitations may include: • The data required to establish a baseline is currently not collected; • The content of such training and its effectiveness will need to be continually re-evaluated as we better understand the health impacts of climate change – ongoing professional development will be required; • It may be more effective to focus training on specific professions (e.g., physicians and emergency responders); • Training provided must lead to useable skills that allow health care workers to respond in a manner they previously would not have been able to – otherwise the value of the training may not be apparent; • Cost of providing training and developing the needed training materials; and • Absolute numbers may not give a clear depiction of the penetration of training in terms of the proportion of health care workers trained nor the geographic distribution of trained health care workers.
OVERLAP WITH OTHER CHAPTERS	Developing and implementing climate change relevant training for health care professionals will require ongoing work to integrate the results of both new developments in research and partnerships with the holders of Indigenous Knowledge. This makes this indicator complementary to the objectives in Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action.
POTENTIAL DATA SOURCES	Implementing this indicator will require partnerships with professional associations and training providers. Possible data sources or partners who could assist in gathering data include: • Professional colleges (e.g., Royal College of Physicians) • Universities and colleges (e.g., Medical schools) • Ministries of health • Ministries responsible for post-secondary education
REFERENCES/MORE INFORMATION	Below are some resources that highlight both the need for enhanced training on the impacts of climate change on health as well as examples of efforts to develop such training. Bell, Erica J. "Climate change: what competencies and which medical education and training approaches?." *BMC Medical Education* 10, no. 1 (2010): 31. Health Canada. *Extreme Heat Events Guidelines: Technical Guide for Health Care Workers*. Ottawa, Ont: Water, Air, Climate Change Bureau, Health Canada. https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/pdf/pubs/climat/workers-guide-travailleurs/extreme-heat-chaleur-accablante-eng.pdf. Rudolph, L & Harrison, C. *A Physician's Guide to Climate Change, Health and Equity*. 2016. Public Health Institute. Oakland, CA: Public Health Institute/Centre for Climate Change and Health. http://climatehealthconnect.org/wp-

	content/uploads/2016/09/FullGuideTEMP.pdf. Maxwell, Janie, and Grant Blashki. "Teaching about climate change in medical education: an opportunity." *Journal of public health research* 5, no. 1 (2016). World Health Organization. *Training course for public health professionals on protecting our health from climate change.* 2018. http://www.who.int/globalchange/training/health_professionals/en/.

9. Number of first responder support programs capable of addressing the physical and mental stresses associated with climate-related hazards

FACTORS TO CONSIDER	
RATIONALE	This indicator documents progress made in ensuring first responder support programs integrate core components of enhancing resilience in responding to the physical and mental health consequences, which first responders experience in their ongoing work to protect Canadians from the impacts of climate change.
METRIC USED	Number of support programs capable of providing assistance to first responders dealing with the mental and physical stresses of climate change.
BASELINE	In order to measure this indicator, the baseline information required includes: • Definition of 'capable'; • Current number of first responder-identified support programs addressing physical stress in Canada; • Current number of first responder-identified support programs addressing mental stress in Canada as having come from climate change impacts; and • Current number of first responder-identified support programs that identify climate change impacts in the above.
CONTEXTUAL INFORMATION	First responders, those who respond to disasters and emergencies, serve the needs of others and place themselves at risk for physical and psychological harm. Accordingly, it is important to enhance their experience of personal and professional growth while ensuring protective systems are in place to prevent avoidable distress and harm (Quevillon et al. 2016, p. 1348). As first responders may be especially at risk for acute and chronic health impacts during disaster and emergency response (Morganstein, 2016), in addition to the accumulation of occupational stress and potential exposure to multiple traumatic events, managerial support and organizational commitment to psychosocial support and personal/professional development are critical (Quevillion et al., 2016). Timely access to mental health care, and other programs designed to provide support in the face of traumatic incidents, emergencies, or disasters can improve health and well-being and reduce the psychosocial and economic consequences for first responders, the agencies they support, and Canada overall.
RELEVANCE FOR INDIGENOUS PEOPLES	As noted, Indigenous Peoples are facing climate change driven events requiring the involvement of first responders at a disproportionate rate to non-Indigenous populations. This is in part due to pre-existing vulnerabilities and limited access to capacities particularly for northern, rural, and remote Indigenous Peoples. Additionally, Indigenous Peoples across Canada are increasingly engaged as and with first responders within their communities and therefore, support programs extend beyond traditional definitions related to urban contexts (Emergency medical services, fire, police etc.) and include support programs and structures for community members acting as first responders in northern and remote communities.
LIMITATIONS	While of critical importance to ensure that first responders have the capacities to

	undertake their work, this indicator is not without limitation. These include: • Baseline data is not currently collected, and may be difficult to obtain; • The evaluation of so-called "capable" support programs requires a significant body of evidence, which may not be available, including evaluation of relevant Indigenous support structures (formal and non-formal); • Resources may not be available to administer surveys.
OVERLAP WITH OTHER CHAPTERS	This indicator needs to consider preparedness of service providers to prepare first responders and then support first responders during and after an event and therefore, connection to aspects of disaster risk reduction and as such overlaps with the preparedness objective in Chapter 4: Reducing Climate-Related Hazards and Disaster Risks. Developing and implementing climate change relevant training for first responders will require ongoing work to integrate the results of both new developments in research as well as partnerships with the holders of Indigenous Knowledge. This makes this indicator complementary to the objectives in Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action.
POTENTIAL DATA SOURCES	• Statistically-significant purposeful sampling of first responders in Canada, in order to identify and subsequently survey those who self-identify as experiencing physical and/or mental stresses associated with climate change effects. • Provincial ministries of health • First Nations and Inuit Health Branch • Individual surveys of supportive health care providers/facilities (i.e., hospitals, counselling centres, Indigenous health structures etc.) • Insurance providers for analysis on claims related to accessing mental health supports
REFERENCES/MORE INFORMATION	Morganstein, J., Benedek, D., & Ursano, R. (2016). Post-Traumatic Stress in Disaster First Responders. *Disaster Med Public Health Prep*. 10(1), 1-2. Quevillon, R. P., Gray, B. L., Erickson, S. E., Gonzalez, E. D., & Jacobs, G. A. (2016). Helping the helpers: assisting staff and volunteer workers before, during, and after disaster relief operations. *Journal of clinical psychology*, *72*(12), 1348-1363. Additional resources identified: https://www.morneaushepell.com/permafiles/63641/changing-landscape-mental-health-support.pdf https://www.tema.ca/first-responder https://www.canada.ca/en/health-canada/services/environmental-workplace-health/occupational-health-safety/employee-assistance-services/psychosocial-emergency-preparedness-response-employee-assistance-services.html http://www.firstrespondersfirst.ca/ http://catchafallingstar.net/ https://www.suicideinfo.ca/wp-content/uploads/2015/05/First-Responders-Toolkit-WEB.pdf

Supporting Particularly Vulnerable Regions

10. Percentage of communities in northern, remote, and coastal areas with community-based, specialized (e.g., coastal erosion, permafrost thaw, etc.) environmental monitoring programs that incorporate climate/weather observations

FACTORS TO CONSIDER	
RATIONALE	This indicator measures the percent of northern, remote, and coastal communities that have a community-based monitoring program for the documentation and dissemination of observations on climate trends and impacts. Measuring the percent of northern, remote, and coastal communities that have a community-monitoring program would help measure incorporation of Indigenous, local, and scientific forms of knowledge to inform community and regional decision making. It also raises awareness and contributes important information for community adaptation initiatives in the face of slow-onset climate events, as well as empowers communities to take control of their data, enabling them to report their observations to decision-makers.
METRIC USED	Quantitative, however qualitative experiences could be sought from members of community-based monitoring programs.
BASELINE	Knowledge of existing community-based monitoring programs, including those existing without federal, provincial, or territorial funding.
CONTEXTUAL INFORMATION	A network of community-based monitors of climate impacts would be responsible for the documentation and dissemination of observations on climate trends and impacts using Indigenous, local, and scientific ways of knowing. Other promising models to draw on include the Local Environmental Observer Network, Indigenous Guardians, and other Environmental Guardians/Watchmen models. The Indigenous Guardians program was supported by the federal government in Budget 2017, which provided an initial investment of $25 million over 5 years.
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is very applicable in northern, remote, and coastal communities, the majority of which are either Indigenous or hold a major population of Indigenous Peoples. Community-based monitoring programs are growing in popularity as they enable Indigenous Peoples to be responsible for the documentation and dissemination of observations of climate trends and impacts. The data collection will be placed back into the hand of the individual communities/regions enabling them to combine Indigenous, local, and scientific ways of knowing. In sum, this indicator can be used to measure progress on Indigenous Peoples' ability to self-determine, including in data collection, decision-making, and monitoring for impacts.
LIMITATIONS	Often, community-based monitoring initiatives depend on having adequate financial resources. As a result, the expansion of these programs is highly dependent on communities securing access to funding. This also means that the majority of current programs are focused on the subject identified in the funding agreement. There have also been challenges for projects that use citizen science to gain legitimacy in peer-reviewed circles. It should be expected that community-based monitoring programs may experience similar concerns.

OVERLAP WITH OTHER CHAPTERS	Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action
POTENTIAL DATA SOURCES	The data used for community-based monitoring programs would combine Indigenous, local, and scientific ways of knowing. As a result, it may be difficult to identify specific data sources before the community settles on a specific combination of Indigenous, local and scientific ways of knowing. The data and information from existing community-based monitoring programs could be collected by federal departments (Environment and Climate Change Canada, Natural Resources Canada, Department of Indigenous Services Canada, etc.), provincial/territorial departments, and others that fund community-based monitoring programs.
REFERENCES/MORE INFORMATION	Success Stories in Australia: https://www.environment.gov.au/indigenous/workingoncountry/publications/pubs/fs-woc.pdf Value in Indigenous Guardians work: http://www.ilinationhood.ca/wp-content/uploads/2016/11/value-in-indigenous-guardian-work-nwt.pdf Overview of Indigenous Guardian Programs in Canada: https://www.indigenousguardianstoolkit.ca/sites/default/files/Community%20Resource_Final%20Report%20with%20Profiles%20March%2027%202015_1.pdf

11. Percentage of population with access to local information on climate change, weather patterns, and associated impacts to regions and sectors in northern, remote, and coastal regions

FACTORS TO CONSIDER	
RATIONALE	This indicator assesses the access of communities in northern, remote, and coastal regions to essential information to measure adaptation to changing climate and weather patterns.
METRIC USED	Quantitative: percentage
BASELINE	The percentage of the population in northern, remote, and coastal regions that has access to information on climate change, weather patterns, and associated impacts measured by access to reliable weather data. The number of sites that record weather and climate data in northern, remote, and coastal regions. The methods used by these sites to disseminate the collected information, including knowledge of local information access points. A scan of monitoring stations and available historical data may be useful before implementing this indicator.
CONTEXTUAL INFORMATION	Northern, remote, and coastal communities might not have access to reliable local weather data if they do not run their own monitoring stations. Additionally, instrument measurements of climate and weather patterns may not exist, and communities may use Indigenous or local science to predict weather and observe patterns. As climate impacts continue to alter their landscapes, these sources of knowledge may have difficulty in keeping up with the changes. Furthermore, communities in northern, remote, and coastal regions may not have access to predictive climate models (such as the UPEI Model) to understand how slow-onset events could impact their region. Ultimately, it is essential that these communities have access to local weather and climate data in order to understand changes in weather and climate patterns to inform adaptation planning and implementation.
RELEVANCE FOR INDIGENOUS PEOPLES	In the context of Indigenous Peoples, this indicator could be particularly useful in remote regions which do not currently receive localized weather information or climate modelling data. Indigenous Knowledge Systems can support implementation of this indicator, as traditional ways of predicting weather and knowledge of weather and climate patterns are still used and shared in many communities. Using Indigenous Knowledge Systems in Indigenous communities could assist in assessing baseline knowledge as well as identifying weather patterns that are changing, even if there are no weather monitoring stations in the region.
LIMITATIONS	Weather and climate data in northern, remote, and coastal regions may be limited and local: community-level data may be even more limited, making it difficult to determine past weather and climate patterns at a small scale. Thus, any access to local weather and climate pattern data would be considered a major improvement, though it might not be enough to effectively increase adaptive capacity. Furthermore, climate modelling can be quite expensive and difficult to access. In order for communities to gain improved access to local weather and climate pattern data, they will require funding and dedicated personnel to operate instruments and report information in an accessible way.

OVERLAP WITH OTHER CHAPTERS	Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action
POTENTIAL DATA SOURCES	Environment and Climate Change Canada, Natural Resources Canada, online sites like the Weather Network.
REFERENCES/MORE INFORMATION	Historical Climate Data Environment Canada Active Weather Stations (2010)

12. Percentage of communities and regions in northern, remote, and coastal areas with planning mechanisms that incorporate or consider climate risk and opportunities

FACTORS TO CONSIDER	
RATIONALE	This indicator documents progress in the development of planning mechanisms, such as risk assessments or adaptation plans, by communities and regions in northern, remote, and coastal areas. Planning mechanisms are an important first step to inform future adaptation action, which must be followed by implementation measures.
METRIC USED	Quantitative: percentage
BASELINE	The types of planning mechanisms that would fall under this indicator must first be identified and defined, including the definition of "climate risk and opportunity". Using this definition, existing planning mechanisms in northern, remote, and coastal communities, including those that are incomplete, must be measured.
CONTEXTUAL INFORMATION	Planning mechanisms like risk assessments or adaptation plans can help mitigate or even avoid impacts that might otherwise have had a serious negative impact on northern, remote, and coastal communities, for example coastal erosion. Identifying risks is the first step in community adaptation to climate change, as most risks from climate change impacts must be known to be addressed. Adaptation plans take this one step further by identifying actions that can be taken to address risks and avoid or mitigate impacts. However, it is important that planning mechanisms not be viewed as an endpoint; rather they should be considered to be a mechanism for the implementation of adaptation actions, and should be supported as such, including through access to funding.
RELEVANCE FOR INDIGENOUS PEOPLES	Planning mechanisms are relevant for Indigenous Peoples when they themselves are in control. It is likely that they will be able to develop community-level solutions that will draw upon Indigenous, local, and scientific ways of knowing. Further, some grants and programs by the federal government require a planning mechanism in place before funding can flow. Planning could therefore enable community access to new sources of funding. As a result, it could also measure progress on Indigenous community infrastructure and development, as well as progress on Indigenous Peoples' ability to self-determine their decision-making in the face of climate impacts.
LIMITATIONS	Planning mechanisms are human, technical, and financially time-consuming. When done in full partnership with community members, planning is time-consuming. Furthermore, the process can be quite technical, because plans require comprehensive reviews and studies involving professionals from many sectors (e.g., construction, environment, infrastructure, operations and maintenance, water management), as well as substantial community engagement. As a result, sufficient funding must be provided.
OVERLAP WITH OTHER CHAPTERS	Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action
POTENTIAL DATA SOURCES	Tribal councils, band councils, community offices, and municipalities
REFERENCES/MORE	Climate Change Vulnerability Assessments with the Ontario First Nations

INFORMATION	Technical Services Corporation.

13. Number of key members of community (e.g., police, firefighters, water technicians, harvesters) with safety training and equipment to adapt to changing conditions

FACTORS TO CONSIDER	
RATIONALE	As slow-onset events continue to increase, the need for safety training and equipment to track, understand, and adapt to these conditions is essential. This indicator measures the number of key community members that have safety training and equipment.
METRIC USED	Quantitative
BASELINE	The number of key community members that have safety training and equipment. Climate-related safety training and equipment standards.
CONTEXTUAL INFORMATION	Communities in northern, remote, and coastal regions rely heavily on the land for their cultural, spiritual, and economic well-being. As a result, members of these communities are more at-risk of experiencing the impacts of slow-onset events, such as thawing permafrost, rising sea level, and species migration. Harvesters, in particular, must go on the land to harvest traditional foods and medicines. There are an increasing number of instances where seasoned harvesters are lost because of changing weather conditions. An increase in the equipment and training of these members may lessen their vulnerability to the changing conditions and thus increase their resilience, while enabling them to conduct their traditional activities. Given the potential socio-economic, spiritual, mental, social, and cultural impacts, as well as the high concentration of communities and economic activities along Canada's coasts and northern regions, there is an urgent need to identify and implement adaptation measures that will improve community and ecosystem resilience.
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is of particular relevance to Indigenous Peoples due to the significance of traditional ways of life, especially in northern, remote, and coastal regions. It will be especially important for governments to prioritize safety training and equipment for those members who depend on the land for their socio-economic, spiritual, social, and cultural well-being. Indigenous Knowledge Systems could be used in the design and implementation of culturally-grounded safety training programs, drawing on Indigenous, local, and scientific ways of knowing. It is essential for Indigenous Peoples to be connected and protected when out on the land.
LIMITATIONS	It may be difficult to collect disaggregated data on the number of people in a given community practicing traditional ways of life. This will also be impacted by other factors, for example access to a car to get to hunting spots or the community's funding for language classes. It might also be difficult to track and monitor data on safety training programs if they are not formally recognized or provided by governments. This also indicates a financial consideration as communities will need to have adequate financial resources to bring in technical expertise and equipment to support the safety training.
OVERLAP WITH OTHER CHAPTERS	Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 6: Translating Scientific Information and Indigenous Knowledge into

	Action
POTENTIAL DATA SOURCES	Community key informants
REFERENCES/MORE INFORMATION	

14. Maximum response times in northern, remote, and coastal regions related to search & rescue and emergency response programming

FACTORS TO CONSIDER	
RATIONALE	This indicator documents the response times for emergency and search and rescue teams. This relates to building resilience in northern, remote, and coastal regions because residents in these regions are in areas of higher risk from climate change impacts and may engage in higher risk activities, e.g., harvesting foods. By measuring maximum response times in northern, remote, and coastal regions and for Indigenous Peoples, we can document improvements (or declines) in emergency response times.
METRIC USED	Quantitative
BASELINE	Knowledge of existing search and rescue and emergency response programming is necessary before a baseline measurement of response times can be made. This data may already exist.
CONTEXTUAL INFORMATION	Maximum response times for emergency and search and rescue programs are essential to document in northern, remote, and coastal regions because these regions have both a higher risk of emergency-related incidents and, especially for northern and remote regions, are often far from emergency service centres. Climate change will affect the weather, water, and land upon which many residents of northern, remote, and coastal regions rely, leading to a rise in the risk of accidents and emergencies.
RELEVANCE FOR INDIGENOUS PEOPLES	In the context of Indigenous Peoples, this indicator is especially important because accidents on the land and ice due to climate change impacts are expected to increase. Living off the land and ice is a fundamental component of many Indigenous cultures so it would be unreasonable to tell Indigenous Peoples to avoid going out on the land. Instead, safety measures and emergency response times should be optimized to reduce risk and limit impacts on people.
LIMITATIONS	There are financial limitations with this indicator, as maximum response times may not improve if the community would require significant investments to improve emergency response or search and rescue programming.
OVERLAP WITH OTHER CHAPTERS	This may overlap with Chapter 4: Reducing Climate-Related Hazards and Disaster Risks due to the disaster and risk component.
POTENTIAL DATA SOURCES	Provincial and territorial governments' emergency management departments Regional/local emergency management departments (e.g., police, fire, ambulance)
REFERENCES/MORE INFORMATION	

15. Percentage of people in northern, remote, and coastal communities whose access to the land, including country foods and traditional ways of life, is impacted by slow-onset events

FACTORS TO CONSIDER	
RATIONALE	Indigenous Peoples' access to the land, including to country foods and traditional ways of life, is central to their identity. As slow-onset events continue to threaten Indigenous Peoples' access to the land, their culture, spirituality, knowledge, and identity are at risk of being lost or altered substantially. This indicator intends to document the percentage of people whose traditional way of life is affected by slow-onset events.
METRIC USED	Quantitative
BASELINE	Providing parameters/categories of traditional ways of life (such as language, harvesting, spirituality, etc.) must be identified for the baseline. Using this baseline, the percentage of people practicing these ways of life can then be calculated.
CONTEXTUAL INFORMATION	Many philosophical thinkers and knowledge keepers have shared the deep connection that First Nations have to "our mother" the Earth, the four directions, the many elements and spiritual teachings about our living world, including our Grandmother Moon and Grandfather Sun. As the prevalence of slow-onset events continues to increase, this connection is threatened. Of particular note, Indigenous Peoples' traditions, cultures, and languages may change or be lost due to climate change impacts (e.g., the loss of words for certain animals that have migrated away). For many, the resurgence of cultural programs — including language programs — is an important way for Indigenous Peoples to build resilience in the face of oncoming threats.
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is of particular relevance to Indigenous Peoples given the significance of traditional ways of life in Indigenous communities, especially northern, remote, and coastal communities. This indicator could also be used as a proxy indicator to measure progress of programs aimed at reconnecting youth to the land, their language, and culture.
LIMITATIONS	It may be difficult to collect disaggregated data on the number of people in a given community practicing traditional ways of life. This will also be impacted by other factors, for example access to a car to get to hunting spots or the community's funding for language classes. It is important when collecting indicator data to identify why people are or are not practicing traditional ways of life.
OVERLAP WITH OTHER CHAPTERS	Chapter 2: Protecting and Improving Human Health and Well-Being
POTENTIAL DATA SOURCES	Provincial and tribal organizations (PTOs), individual communities and nations, community services
REFERENCES/MORE INFORMATION	Centre for Indigenous Environmental Resources (CIER) for Assembly of First Nations (AFN): How climate change uniquely impacts the physical, social and cultural aspects of First Nations National Climate Assessment: Indigenous Peoples, Lands, and Resources https://www.fs.fed.us/pnw/pubs/pnw_gtr944.pdf Kyle Whyte: Climate Change and Indigenous Peoples

16. Number of funded initiatives directed at protecting cultural assets (e.g., archaeological/historical sites, spiritual sites, traditional foods/plants/medicines) located in vulnerable regions from climate risks

FACTORS TO CONSIDER	
RATIONALE	This indicator documents the protection of cultural assets of northern, remote, and coastal regions/communities that are under threat from climate change impacts. It is important to build resilience in this area because, as vulnerability is defined, these assets may be permanently lost due to climate change.
METRIC USED	Qualitative assessment of cultural assets, quantitative counting of number of funded initiatives
BASELINE	Knowledge of cultural assets in vulnerable regions/communities Knowledge of current funding initiatives to protect cultural assets and how many communities/regions are accessing these funds
CONTEXTUAL INFORMATION	Cultural assets are particularly vulnerable to impacts of climate change because they do not regenerate. These assets may be located in especially vulnerable regions, along coastlines or in northern or remote locations that are difficult to protect. A scan of existing funding to protect cultural assets must be completed for each region before this indicator can be used.
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is particularly relevant in the context of Indigenous Peoples because climate change may permanently destroy cultural assets. This is an especially grave prospect given the already existing stressors on Indigenous cultures and their assets (e.g., colonialism and residential schools). When gathering data on the number of funded initiatives to protect cultural assets in northern, remote, and coastal communities, it may be useful to compile a list of these initiatives for distribution to Indigenous Peoples.
LIMITATIONS	Some cultural assets may not be identified and Indigenous Peoples may not want to share locations/information about certain sacred cultural assets. The use of funding must also be tracked to give this indicator more meaning.
OVERLAP WITH OTHER CHAPTERS	While this is likely specific to vulnerable regions, it may overlap with Chapter 2: Protecting and Improving Human Health and Well-Being and Chapter 5: Building Climate Resilience through Infrastructure.
POTENTIAL DATA SOURCES	Environment and Climate Change Canada Ministry of Canadian Heritage Museums, cultural centers, and Indigenous Peoples key informants
REFERENCES/MORE INFORMATION	Centre for Indigenous Environmental Resources (CIER) for Assembly of First Nations (AFN): How climate change uniquely impacts the physical, social and cultural aspects of First Nations National Parks Service: Climate Change Impacts on Cultural Resources Kyle Whyte: Indigenous peoples, climate change loss and damage, and responsibility of settler states

17. Percentage of northern, remote, and coastal communities with experienced and/or trained locals (including Elders with Indigenous Knowledge Systems) that are designing and implementing adaptation actions in their regions and/or communities

FACTORS TO CONSIDER	
RATIONALE	This indicator measures the percentage of northern, remote, and coastal communities with experienced and/or trained locals in designing and implementing adaptation actions. Having experienced and/or trained locals will empower communities to design and implement the planning mechanisms outlined in indicator 12.
METRIC USED	Quantitative; measuring number of experienced and/or trained locals.
BASELINE	The number of experienced and/or trained locals that are designing and implementing adaptation actions. The status of those adaptation actions.
CONTEXTUAL INFORMATION	Experienced and/or trained locals that are designing and implementing adaptation actions can help minimize the severity of impacts (e.g., coastal erosion) on northern, remote, and coastal communities, . The localization of talent/expertise will enable communities to reduce the heavy cost of planning mechanisms and ensure that culturally grounded and relevant adaptation plans are created. It will also facilitate ongoing support to implement the plan.
RELEVANCE FOR INDIGENOUS PEOPLES	Experienced and/or trained locals that are designing and implementing adaptation actions can support the self-determination efforts of Indigenous Peoples. These locals will draw upon Indigenous, local, and scientific ways of knowing. Furthermore, some grants and programs by the federal government require a planning mechanism in place before funding is allocated. This would enable those communities access to new sources of funding, as well as reduce the heavy costs associated with outside consultants. As a result, it could also measure progress on Indigenous Peoples' ability to self-determine their decision-making in the face of climate impacts.
LIMITATIONS	As planning mechanisms are human, technical, and financially time-consuming, having experienced and/or trained locals may reduce some of the technical and human burden associated with adaptation planning. However, it will continue to be consuming and financially expensive, requiring adequate funding.
OVERLAP WITH OTHER CHAPTERS	Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action
POTENTIAL DATA SOURCES	Provincial climate change organizations (e.g., Ouranos, OCCIAR), federal departments with climate change adaptation funding (e.g., CIRNA, ISC, ECCC), academic researchers
REFERENCES/MORE INFORMATION	

18. Number of adaptation initiatives and/or formal agreements (MOUs, etc.) that include a multi-stakeholder approach (governments, communities, Indigenous Peoples, private sector, and others) for regional planning

FACTORS TO CONSIDER	
RATIONALE	This indicator documents regional adaptation planning agreements that use a multi-stakeholder approach. This is important for resilience because it facilitates cross-sectoral knowledge-sharing and mutually-beneficial partnerships.
METRIC USED	Quantitative: number of plans with and without agreements
BASELINE	First, a "multi-stakeholder approach" must be defined (if not, agreements that exclude Indigenous rights holders may be counted etc.). Then, all existing initiatives must be counted.
CONTEXTUAL INFORMATION	Better outcomes can be achieved by taking a multi-stakeholder approach to regional adaptation planning. A comprehensive and inclusive process would include all stakeholders who want to participate (e.g., non-governmental organizations, governments, municipalities, Indigenous Peoples, Tribal Councils, etc.). This will avoid future disagreements and build positive relationships. As well, knowledge will be shared across sectors which might otherwise have not been accessible. This will lead to more effective and comprehensive adaptation plans, with all stakeholders in the region on board and supportive. This support will also be useful when applying for funding to implement regional adaptation plans.
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is of significance to Indigenous Peoples because of its potential for multi-stakeholder and multi-government partnerships in building regional adaptation plans. This is an opportunity for First Nations to assert jurisdiction and work on a nation-to-nation basis with other governments and is also an opportunity for governments and stakeholders to learn about, respect, and incorporate Aboriginal and Treaty Rights in their planning.
LIMITATIONS	It will be challenging to define "multi-stakeholder" because there are many stakeholders who could participate in regional adaptation planning, leading to the possibility of accidental omissions. Data sources might be difficult to identify unless regional authorities supply data.
OVERLAP WITH OTHER CHAPTERS	Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action Chapter 7: Implementing a Sustainable Approach to Monitoring Progress on Adaptation
POTENTIAL DATA SOURCES	Regional governments and authorities
REFERENCES/MORE INFORMATION	

Reducing Climate-Related Hazards and Disaster Risks

19. Percentage or number of communities with development and re-development 'build back better' control policies, bylaws and regulatory tools for climate-related hazards that are culturally appropriate and include Indigenous Knowledge Systems where appropriate

FACTORS TO CONSIDER	
RATIONALE	While there are many communities that are vulnerable to climate hazards, one of the easiest ways to reduce future risk is to have policies and plans at the federal, provincial, community and municipal levels in place before a hazard occurs to ensure communities are prepared to 'build back better' from the event in recovery, rehabilitation, and reconstruction. This includes, for example, policies that may direct new buildings or infrastructure development away from hazard prone areas in the first place or to direct the guidelines required to ensure greater resilience of existing buildings and infrastructure to that hazard. For example, this may include 'build back better' policies to flood proof or fire proof structures, where deemed necessary to rebuild in the hazard area, and not to relocate. 'Build back better' also refers to preparedness and planning measures to support the recovery and rehabilitation of communities (e.g., ensuring that social determinants of health are met and that the community systems that support them are more resilient). Please refer to Chapter 2: Protecting and Improving Human Health and Well-Being for further information.
METRIC USED	Number of communities adopting development control and 'build back better' policies. The content of each policy may vary widely so some minimum requirements may be warranted. Intent is to show community preparedness for reducing exposure over the long term.
BASELINE	This would require a scan of provincial and local policy, regulation, or other development control tools to develop current baseline of the types and extent of coverage. The climate hazards should be accompanied by risk mapping (what is located within the climate hazard area) to determine where policy is to be focused.
CONTEXTUAL INFORMATION	• This indicator measures the number of communities who have explicitly incorporated development control measures into their planning and building policies, regulations, laws and codes that address various climate risks and direct the avoidance, mitigation and rebuilding aspects of development with respect to the various relevant risks in that community. • While it may do little to address existing development in areas of climate risk, it will reduce future risk of new development and the risk to existing development when rebuilding or restoring needs to occur post-event, with the ultimate goal of reducing future risk. • In order to meaningfully apply policy requirements, the potential for climate hazard risk to be present should be mapped or defined to allow for appropriate policy and regulatory responses.

	The indicator should be disaggregated by: • Hazard type, such as river flooding, shoreline flooding, stormwater flooding, wildfires, and permafrost thawing. • Region such as coastal, northern, remote, prairies, mountains, urban, rural.
RELEVANCE FOR INDIGENOUS PEOPLES	• This indicator is applicable to all communities in Canada. • Indigenous Knowledge Systems can support the understanding of what and where climate hazard impacts are that require policy or design intervention to reduce the risk in Indigenous communities and what the appropriate regulatory and policy responses may be in individual communities.
LIMITATIONS	• It will take some work to develop the baseline data for existing policy and regulations. • Hazard mapping is not completed everywhere yet and most do not incorporate the increased hazards related to climate change. • The state of planning documents is always in flux (e.g., updates and approvals) and there is no one timeframe to update from. • Guidance on what should be included in 'build back better' policies should be developed to have consistency on minimum standards across the country.
OVERLAP WITH OTHER CHAPTERS	Similar indicators may be in Chapter 2: Protecting and Improving Human Health and Well-Being, Chapter 3: Supporting Particularly Vulnerable Regions, and Chapter 5: Building Climate Resilience through Infrastructure. The mapping of climate hazard is also related to Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action
POTENTIAL DATA SOURCES	For example: • Municipal official plans • Emergency response, preparedness or recovery plans • Provincial policy statements • Provincial laws and regulations related to development and building • Building codes • By-laws; zoning documents
REFERENCES/MORE INFORMATION	Ontario Conservation Authorities Act and associated regulations (flood, shoreline, slope and erosion hazards)

20. Percentage or number of communities with climate-related hazard mapping incorporating climate change utilizing scientific information and, where appropriate, Indigenous Knowledge Systems

FACTORS TO CONSIDER	
RATIONALE	By identifying the hazard risks based on current and projected climate information (e.g., flooding, fire, heat trends), communities will be able to better assess, predict, plan, and prepare for climate-related risks. The mapping of hazards, based on current and future climate conditions, enables the visualization of current and future high-risk areas, which can be overlaid with existing or expected community or infrastructure vulnerabilities and/or sensitivities to support sound decision-making, planning, and investments to reduce the impacts of these disasters on communities. This indicator seeks to track the number of communities that have climate hazard maps that a) have been prepared or updated recently, and b) take into account potential extreme weather events due to climate change.
METRIC USED	Number of distinct Canadian communities with climate hazard maps that have been prepared or updated. Could be measured according to a timeframe such as within the past [5 or7] years.
BASELINE	• Number of communities within Canada • Number of communities with comprehensive climate hazard maps that have been prepared including climate change extremes
CONTEXTUAL INFORMATION	This indicator will require a national standard for comprehensive climate hazard mapping. This national standard should take into account the size of a community, its level of urbanization and proximity to hazard areas such as bodies of water. Since the majority of climate hazard mapping will be focused on flooding, communities will need access to up-to-date flood maps of their community. Guidance would also be needed on what future scenario should be planned for (e.g., 2050s mid-estimate or high-estimate, 2080s mid-estimate, etc.). The indicator could be disaggregated by: • Hazard type, such as river flooding, shoreline flooding, stormwater flooding, wildfires, heat, infectious diseases, and permafrost thaw • Region, such as coastal, northern, remote, urban or rural, Indigenous land, prairies, mountains
RELEVANCE FOR INDIGENOUS PEOPLES	Nearly all the climate-related hazards are applicable to Indigenous Peoples, particularly since many Indigenous Peoples reside near water sources (e.g., rivers, lakes, and coasts) that are vulnerable to flooding. Climate hazard mapping will assist Indigenous Peoples in planning related to infrastructure design methods and emergency management to reduce risks; however recognizing that traditional ways of life are closely connected to watercourses and local and cultural relevance in design is critical. Permafrost thaw, coastal flooding risk, and wildfires will be climate hazards being mapped and these hazards are very relevant to northern Indigenous Peoples.

	Vast areas of the north are in climate hazard areas and thus the solutions are more nuanced than solutions being considered for more urban centers in southern/central Canada.
LIMITATIONS	• We are not aware that this information is being gathered. • Flood mapping is not current or available for many jurisdictions. • A national standard will need to be developed for what will constitute an acceptable climate hazard mapping plan for a community; current level of mapping (100-yr, 200-yr, 500-yr, regional storm, etc.) varies between provinces and territories and need to be standardized or at least a minimum level adopted across the country. • The universe of communities will need to be identified (avoid duplication or gaps). • Some hazard mapping will be embedded within community plans and may not be a stand-alone document. • Some information may be supported through the continued development of the Federal Floodplain Mapping Guidelines Series or through the work of the Federal Geospatial Platform.
OVERLAP WITH OTHER CHAPTERS	As climate hazard mapping is foundational to all work related to climate change adaptation, this indicator is related to all other chapters in this report.
POTENTIAL DATA SOURCES	
REFERENCES/MORE INFORMATION	Refer to “Preventing Disaster Before it Strikes: Developing a Canadian Standard for New Flood Resilient Residential Communities” by Intact Center on Climate Adaptation, September 2017. Table 3 summarized the regulatory flood for each province and territory as well as associated definitions of floodway and flood fringe.

21. Number of high-risk vulnerable populations in locally identified high-risk climate hazard areas (not accounting for defenses)

FACTORS TO CONSIDER	
RATIONALE	Vulnerable populations are more challenged to adapt, respond, and recover from extreme weather and climate-related events due to pre-existing physical, health and well-being, and socio-economic inequities and vulnerabilities that are exacerbated in emergencies and disasters. The intention of this indicator is to examine the exposure of vulnerable citizens in high risk climate hazard areas, and to measure how effective efforts have been to reduce those disproportionate vulnerabilities.
METRIC USED	Percentage of the population deemed vulnerable that live in a high risk climate hazard area.
BASELINE	We need to identify the high risk climate hazard areas, determine the aggregate population in these areas, and identify the number of people deemed vulnerable.
CONTEXTUAL INFORMATION	Vulnerable populations have been defined to include 10 categories of people who have less financial, physical, mental, and/or social ability to adapt to climate hazard events. These populations are disproportionately impacted by the costs of adaptation or a climate event. A flooded basement apartment may result in a personal financial crisis for a low income person and their ability to recover is a major challenge. The 10 categories of vulnerable populations identified by Canadian Red Cross include: Indigenous Peoples, seniors, persons with disability, medically dependent persons, low-income residents, children and youth, persons with low literacy levels, women, transient populations, new immigrants, and cultural minorities. The indicator could be disaggregated by: • 10 high-risk vulnerable populations. Given that some vulnerable people will be represented in multiple categories, caution will be required for the interpretation • Hazard type, such as river flooding, shoreline flooding, stormwater flooding, wildfires, and permafrost thawing • Region such as coastal, northern, remote, prairies, mountains, urban, rural • Can be complimented with numbers of vulnerable populations accounting for defenses An objective of this indicator is to reduce the percentage exposed to the climate hazards. It can be achieved by reducing the number of vulnerable people in the high risk climate hazard area and/or reducing the size and number of high risk areas.
RELEVANCE FOR INDIGENOUS PEOPLES	• Many Indigenous Peoples are deemed vulnerable due to their location and financial situation • Many Indigenous Peoples are in high risk climate hazard areas; • Government financial assistance and infrastructure funding will help to address this issue

LIMITATIONS	• Gathering data • Given that some vulnerable people will be represented in multiple categories, caution will be required for the interpretation. • What actions to take as a result of this indicator
OVERLAP WITH OTHER CHAPTERS	The exposure of vulnerable populations within climate hazard areas is relevant to all other chapters in this report.
POTENTIAL DATA SOURCES	Public Safety Canada Statistics Canada
REFERENCES/MORE INFORMATION	Integrating Emergency Management and High-Risk Populations: Survey Report and Action Recommendations. Prepared by Canadian Red Cross for Public Safety Canada, December 2007

22. Number of properties (residential and businesses) in climate adjusted river and shoreline flood hazard areas (not accounting for defenses)

FACTORS TO CONSIDER	
RATIONALE	While flooding will occur with or without climate change, the increasing magnitude, intensity, and frequency of floods is expected to continue to change. This indicator documents the progress to accurately delineating risk from riverine and shoreline flooding and progress to de-risking areas through mitigation/remedial measures. The intent is to prevent increased exposure to these riverine or shoreline flooding hazards, to protect what cannot be removed and to deter densification within these high-risk areas.
METRIC USED	Measuring the number of properties (and/or physical structures) in the floodplain that can then be used to estimate population affected and vulnerability of those structures (e.g., schools, institutional uses; low income neighborhoods). OECD currently measures the number of properties in climate hazard areas but the Expert Panel recommends focusing on river and shoreline areas at this point.
BASELINE	River and shoreline mapping including impacts of climate change. Assess existing number of properties within these areas. Floodplain mapping is being completed across the country. (The National Disaster Mitigation Plan program is supporting significant updates to old mapping and developing new mapping where it did not previously exist.) These do not include considerations of climate change impacts.
CONTEXTUAL INFORMATION	• We chose river and shoreline flooding over urban (i.e. pluvial/overland) flooding mapping for a couple of reasons. It remains a good indicator of climate change impacts, it is mapped to a similar standard across the country (using accepted engineering practices), it tends to be publically available (not proprietary), this type of flooding routinely occurs in the same place allowing more tracking of change over time, and it is currently an investment being made by the federal government for disaster reduction. • Pluvial flooding impacts can be captured with damage estimates and acute infrastructure or service failure. • While flooding will occur with or without climate change, we can expect to see changes in the magnitude and frequency of floods. • Pre-cursory information: presumes that sufficient mapping is available across the country. The indicator could be disaggregated by: • Property or building type: single family, multi-family, business, industrial, etc. • Can be complimented with numbers of properties accounting for defenses. Once digital mapping is complete, it typically only needs to be updated when there are significant changes to land use, infrastructure or climate/rainfall assumptions.
RELEVANCE FOR INDIGENOUS	• River or shoreline (coastal) flooding affects all communities and urban flooding affects developed areas.

PEOPLES	• Limits of inundation can be supported by Indigenous Knowledge Systems • Most Indigenous Peoples are located near water sources (rivers, lakes and coasts) and their local and cultural ways of life need to be considered in managing exposure to river and shoreline flooding.
LIMITATIONS	• Progress is slow nationally • Age of existing maps • Climate change not incorporated into maps • Older maps are not digital; need digital base mapping and tools to easily track this indicator • Mapping standards are generally available but may not map the same return frequency across the country • Lack of standard river or shoreline hazard delineation method • Remote sensing may not accurately represent all structures (e.g., temporary; rural under tree cover) • Number of properties do not always equate to risk – particularly in rural and agricultural situations • Densification of development (i.e., apartment buildings may count as one structure but many people live in it – can't tell if situation is getting worse)
OVERLAP WITH OTHER CHAPTERS	The amount of exposure within river and shoreline flood hazard areas is relevant to all chapters in this report.
POTENTIAL DATA SOURCES	• Provinces • Conservation authorities (Ontario) • Water management agencies • Municipalities • Public Safety Canada • Statistics Canada
REFERENCES/MORE INFORMATION	• Federal Disaster Reduction Program of 1970s • National Floodplain Mapping Assessment - Final Report MMM Group 2014 • NDMP programs • Technical Guide River & Stream Systems: Flooding Hazard Limit , Ontario Ministry of Natural Resources 2002 • Guidelines for Developing Schedules of Regulated Areas (Conservation Ontario, 2003) • Federal Floodplain Mapping Guidelines

23. Number of watershed or regional-scale water management plans incorporating future water supply due to climate change

FACTORS TO CONSIDER	
RATIONALE	Climate change impacts may also include a change in the frequency and duration of droughts due to prolonged periods of hot and dry conditions. While drought may not be an acute hazard in the way of floods and wildfires, it has the potential to affect many people, can lead to immediate and long-term consequences for the health and safety of Canadians, and requires similar emergency responses to rapid-onset disasters. Water management plans need to incorporate climate change impacts on water supplies under a variety of climate scenarios to support developing drought management and response plans that ensure sufficient supply now and in a future climate. In addition, water management planning should be done at a watershed and/or regional scale to balance the needs of all stakeholders for collective economic well-being as the water supply and demand changes. Like other climate hazards, the past is not a good predictor of future conditions.
METRIC USED	Number of watershed or regional-scale water management plans incorporating future water supply due to climate change
BASELINE	Review of watershed, regional, municipal or other community led water supply/ water servicing plans for climate scenarios. Review of source protection plans or water budgets by basin/watershed or other boundary. Review of low water response programs by province. Define areas of higher risk to drought – risk mapping could be done by others.
CONTEXTUAL INFORMATION	Most organized governments have developed long range servicing strategies to address the location and quantities of water supply needed for growth. While the supply may be tested against various historical conditions (e.g., 7Q20; recorded water levels), incorporating climate change into these predictions is still emerging. For example, source water protection plans in Ontario have emphasized the development of water budgets for municipal supplies and have identified areas within a watershed of existing and potential water quantity stress. This activity could be undertaken consistently across the country to identify areas at high risk of drought impacts. Policies could then be put in place and monitoring of low water conditions instituted to be prepared, warn, and manage low water when it happens. Water allocation remains a difficult topic to address in the best of times. This indicator could be disaggregated by: • Region, watershed or province/territory
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is applicable to all communities with centralized or private water supplies. Local and Indigenous Knowledge Systems can aid in delineating water supply

	boundaries, and in identifying areas of known water stress. The specific needs of Indigenous Peoples must also be included in watershed and/or regional water management plans.
LIMITATIONS	
OVERLAP WITH OTHER CHAPTERS	The risks to long term water availability impacts actions to all chapters in this report. Knowing the extent of the hazard is important for knowledge to action.
POTENTIAL DATA SOURCES	• Municipal long range water supply plans • Ontario Source Protection Plans (https://www.ontario.ca/page/source-protection) • Ontario Low Water Response Program (https://www.ontario.ca/page/low-water-response-program) • Province of Alberta (http://aep.alberta.ca/forms-maps-services/directives/documents/PreparingWaterShortageResponse-Apr23-2014A.pdf) • Other water management authorities/entities
REFERENCES/MORE INFORMATION	

24. Percentage or number of communities that have developed or updated emergency response plans that consider future climate-related hazard extremes

FACTORS TO CONSIDER	
RATIONALE	Communities are better able to respond to climate event disasters if they have a plan that has been developed in partnership with, and has been appropriately communicated to, first responders, community members, emergency management offices, volunteer organizations, and Indigenous Peoples. Such plans will mitigate the event in the first instance, enhance the response, and shorten the recovery for the people in the affected area. Many emergency response plans already exist but need to be updated to consider the extremes associated with climate change; and to include meaningful community-based participatory processes throughout the design, implementation, and review of these plans.
METRIC USED	Number of communities with climate event disaster response plans that were co-created with representatives of high-risk populations.
BASELINE	A national standard for an acceptable disaster and emergency response plan will be required, that includes considerations of climate change impacts, and the meaningful participation of communities and Indigenous Peoples. Such a standard will include the scope of the plan, the level of detail and how recently it has been prepared or updated with climate information.
CONTEXTUAL INFORMATION	• Many communities, particularly the larger urban centres, have disaster response plans. These plans encompass many potential scenarios, not just extreme weather events or climate induced events, such as wildfires. • The Expert Panel believes that every community should consider extreme weather events with current climate change information, such as flood mapping. Developing a disaster response plan that integrates this information will improve the quality of the response and shorten the recovery time. First responders (which vary locally, not just police and fire) and employees of critical infrastructure organizations will need to know the response in advance with this plan. • Response and recovery plans should be co-created with representatives of high-risk vulnerable populations, since these groups may have unique needs during and after and event, have the least capacity to adapt and recover, and need to be engaged early to be advocates and trusted voices in these groups. • A national standard will need to be developed that will qualify a disaster response plan for extreme climate events. Such a standard will need to include the most recent information and forecast for long term impacts. • Extreme weather and climate disaster response plans need not be a stand-alone plan, but may be part of a comprehensive plan by a community • This indicator does not consider the relative population or territory (square km) covered by an extreme weather disaster recovery plan, but is easier to quantify by community. The indicator could be disaggregated by:

	• Hazard type, such as river flooding, coastal flooding, stormwater flooding, wildfires, and permafrost thawing. • Region such as coastal, northern, remote, prairies, mountains, urban, rural. • 10 high-risk vulnerable populations: Locally- identified vulnerable populations should be included in the planning of response plans and seeing which groups have been included will show this over time.
RELEVANCE FOR INDIGENOUS PEOPLES	Many Indigenous Peoples live in remote or hazard prone areas with limited resources and underlying socio-economic challenges, where response activities may be inadequate, response times may be longer, evacuations often last longer, and thus capacity building within the community to respond to climate-related events is essential. First response capacities and capabilities differ significantly across Canada, with remote and northern areas having less capacity and resources. Indigenous Peoples are stewards of the land, and drivers of change with a strong role in developing and implementing emergency response plans in their areas to ensure plans are regionally specific, culturally appropriate and relevant to their needs and capacities.
LIMITATIONS	• Need a national standard to determine a qualifying plan • Need to gather data on which communities have such a qualifying plan • Plans may go out of date if they have not been updated based on timing guidelines within a national standard
OVERLAP WITH OTHER CHAPTERS	These plans are directly tied to infrastructure and temporary measures or response actions that are required due to the exposure of infrastructure and people to that climate hazard (Chapter 5: Building Climate Resilience through Infrastructure). Response during an event directly and indirectly affects people based on their exposure and the more effective prepared and proactive emergency response, the decreased impact on people, property and the environment. Vulnerable regions typically have less access to emergency support services and thus their emergency response plans need to consider their local context (Chapter 3: Supporting Particularly Vulnerable Regions).
POTENTIAL DATA SOURCES	
REFERENCES/MORE INFORMATION	

25. Percentage or number of emergency management organizations that have representatives of local and/or regional high-risk vulnerable populations that participate in prioritization and decision-making

FACTORS TO CONSIDER	
RATIONALE	Emergency management organizations should have representatives from vulnerable sector associations or populations on their committees. This indicator identifies that in order for emergency management organizations to be effective, they need to have information on where vulnerable populations are at risk, from what climate-related hazards, and how to communicate with, access, and properly support them in the event of a climate-related disaster.
METRIC USED	Percentage (or number of) emergency management organizations that have members representing local and/or regional high-risk vulnerable populations
BASELINE	Membership of emergency management organizations provincially and locally Identify vulnerable sector associations, leaders provincially and locally
CONTEXTUAL INFORMATION	Certain sub-populations are especially vulnerable to climate change and have unique requirements to respond and recover from disaster events. Analysis by Canadian Red Cross for Public Safety Canada determined that significant gaps exist in meeting the needs of high-risk populations where resources as well as networking and bridge-building between emergency management and voluntary organizations serving high-risk populations is needed at all levels. In times of emergency, vulnerable sectors may need special consideration. This may mean assistance with mobility, language interpretation, religious customs, medical requirements, culturally appropriate foods, longer term shelter and support, financial aid, etc. For example, basement flooding may leave basement apartment dwellers homeless for an extended period of time. They may not have renters insurance or perhaps access to support groups. Newcomers to Canada may not have knowledge or understand the directions of how to get assistance or be wary of first responders. Remote First Nations communities may need to be evacuated many miles away from their livelihoods and families and for extended periods of time. These are some examples of the many scenarios that may play out during hazard situations. If representatives from the organizations who work with vulnerable populations or local community members work with the emergency management organizations they can identify locations of vulnerable populations or individuals, plan for the appropriate responses, and aid in the response when the time comes. This should reduce stress and help to keep the focus on recovery for these often under-served populations. The indicator should be disaggregated by: • Region such as coastal, northern, remote, prairies, mountains, urban, rural. • 10 high-risk vulnerable populations. Given that some vulnerable people will be represented in multiple categories, caution will be required for the interpretation.

RELEVANCE FOR INDIGENOUS PEOPLES	Indigenous Peoples should be included in emergency response planning to capture the unique needs of Indigenous Peoples throughout the entire process of preparedness, response, and recovery. By being part of the planning phase Indigenous Peoples can integrate their specific needs (e.g., adequate equipment, supplies and training). If Indigenous Peoples are involved in the preparedness phase then they can provide a consistent continuing voice at the table during response and recovery efforts. Indigenous Peoples should also have a role in prioritization of actions and decision making during an event.
LIMITATIONS	• Identifying the various vulnerable populations for every hazard type is a significant amount of work • A lot of individuals to identify in communities to provide perspective and voices to aid in emergency management and response
OVERLAP WITH OTHER CHAPTERS	This is related to all chapters in this report. Involvement by vulnerable populations will help to build knowledge or risks in order to create action across all stakeholders. The actions for emergency response and recovery by vulnerable groups will provide guidance to some infrastructure and health and well-being actions. Vulnerable regions have different response and recovery actions than more urban centers with many emergency actions falling to individuals in the communities and therefore for a response plan to be useful, it needs to involve the local context for actions.
POTENTIAL DATA SOURCES	Public Safety Canada Provincial emergency management organizations Municipal emergency management organizations Canadian Red Cross
REFERENCES/MORE INFORMATION	Lindsay and Hall, "Older Persons in Emergency and Disaster" Integrating Emergency Management and High-Risk Populations: Survey Report and Action Recommendations. Prepared by Canadian Red Cross for Public Safety Canada, December 2007.

26. Number of hours of climate-related disaster response training and exercises

FACTORS TO CONSIDER	
RATIONALE	Due to the scale of impact and the nature of the impact from climate-related disasters, first responders need to be considered in a local or regional context. The response during a climate-related disaster requires actions across many sectors and industries and thus training and exercises need to extend beyond fire, police, and emergency medical services (EMS) but include emergency management organizations (EMOs), representatives from vulnerable populations, and operators of critical infrastructure and basic services. The integration of lessons learned following exercises and training is also crucial, to ensure identified gaps and opportunities for improvement are considered. First responders spend the majority of their training time on routine calls, such as fire, health-related emergencies, and violence. But time and again we have seen that other kinds of climate-related disasters need different responses and tools. These events may occur infrequently so regular and ongoing exercises are required to maintain a state of preparedness, if not for a given area but to be able to respond to neighbors when need arises.
METRIC USED	Number of hours of climate-related disaster response training or exercises
BASELINE	Collect the training activities of first responders and EMOs from across the country, ideally from every community but recognizing that extrapolation regionally may be possible.
CONTEXTUAL INFORMATION	Training for climate-related disasters should consider things such as: • Evacuation protocols and supports • Potential for widespread power and telecommunication outages • Compromise of water quality and availability • Communication mechanisms specifically including vulnerable populations • Interruption to major transportation routes • Time to enact response actions including temporary protection measures • Process to access supplies during an emergency (i.e., pumps, riprap to protect from active erosion, chemicals for water treatment, etc.) • Increased demands on health and medical facilities • Knowledge of climate-related hazard areas and the exposure of critical infrastructure, essential services and vulnerable populations, and • Impacts to business continuity for various industries. Working with partner agencies, different scenarios can be enacted to test assumptions, knowledge, and potential challenges with implementation of actions. The indicator could be disaggregated by: • Sector type such as fire, police, medical, rangers, GSAR, municipal workers, EMOs, etc. • Hazard type, such as river flooding, coastal flooding, stormwater flooding, wildfires, and permafrost thawing. • Infrastructure category such as power supply, water supply,

	telecommunications, transportation, etc. • Region such as coastal, northern, remote, prairies, mountains, urban, rural.
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is applicable to all communities. Indigenous Peoples may have unique requirements for emergency response such as who would be involved in the response during a climate-related disaster. By conducting training and exercises, challenges or specific vulnerabilities may be identified and could be planned for in advance of experiencing a climate-related disaster.
LIMITATIONS	• The knowledge of where floodplains may extend to is not available everywhere yet. • The monitoring tools such as real-time gauges to observe rainfall or stream flow as well as predictive models are lacking in many locations. • Even with training, events often happen rapidly and randomly without ability to put training into use.
OVERLAP WITH OTHER CHAPTERS	This is related to all chapters in this report. Exercises will test temporary measures associated with infrastructure, response capacity at health and medical facilities, and specific requirements for response in vulnerable regions.
POTENTIAL DATA SOURCES	Emergency Management Organizations (EMOs) Municipalities Provinces National fire and police associations/organizations
REFERENCES/MORE INFORMATION	

27. Percentage or number of culturally and locally relevant emergency response warning systems focusing on high-risk vulnerable populations

FACTORS TO CONSIDER	
RATIONALE	Access to warning systems that are relevant to local conditions, particularly for high risk populations and for groups that support those high-risk populations, may improve resilience to disasters by increasing awareness of disasters, facilitating rapid emergency response actions, and consequently improving access to assistance or relief. Documenting the types of warning systems currently in use, particularly for high risk populations, and those that support them, can therefore assess an important element of resilience in those populations.
METRIC USED	Percentage (or number) of culturally and locally relevant emergency response warning systems focusing on high-risk vulnerable populations
BASELINE	The number and types of warning systems currently in place Best practices summary
CONTEXTUAL INFORMATION	More effort has been placed in recent years in getting warnings out to Canadians about weather systems and the potential for them to become dangerous. Flood warning systems have been put in place in many communities to communicate risks and expected activities. Communications of these warnings are not always provided in locally-relevant systems. Warnings often come through routine channels of radio, television, and email, with some provided in one language only. All rely on some kind of technology to get the word out. Some of the most vulnerable populations may not be within reach of such warnings (e.g., elderly, homeless, new Canadians, remote populations). Their ability to take appropriate actions is not only hampered by inaccessible information but often by their social or financial status. Further, some of the warning systems in place apply to very large regions for which local variability is not considered. Without the ability to have locally relevant warnings, they may be ignored and result in greater injury or potentially loss of life because they could not be relied upon. More locally-specific response actions such as evacuation of an area will rely on local communications. The indicator should be disaggregated by: • 10 high-risk vulnerable populations: Locally- identified vulnerable populations should be included in the planning of response plans and seeing which groups have been included will show this over time. • Hazard type, such as river flooding, shoreline flooding, stormwater flooding, wildfires, and permafrost thawing.
RELEVANCE FOR INDIGENOUS PEOPLES	Emergency warning and response actions may come from locally-identified Indigenous leaders and should be supported in the planning of communications and warning systems.
LIMITATIONS	Getting warnings out in a timely manner to the myriad of high risk and vulnerable populations or those that support them is a significant task. It means different methods of communication, including technologies, languages as well as

	education about what the message means for them and the action that needs to be taken.
OVERLAP WITH OTHER CHAPTERS	This is related to all chapters in this report. Infrastructure and emergency planning are necessary to support warning systems, health and well-being and vulnerable regions speaks to the unique requirements of certain populations and knowledge to action should align with emergency actions during a climate-related disaster event.
POTENTIAL DATA SOURCES	Canadian Red Cross Environment Canada Weather Conservation Authorities in Ontario Municipalities (heat and cold alerts)
REFERENCES/MORE INFORMATION	https://www.grandriver.ca/en/our-watershed/Flood-warning-system.aspx https://weather.gc.ca/warnings/index_e.html https://www.toronto.ca/community-people/health-wellness-care/health-programs-advice/extreme-cold-weather/ https://www.toronto.ca/community-people/housing-shelter/homeless-help/

28. Average speed of emergency response to an event focused on high-risk vulnerable populations

FACTORS TO CONSIDER	
RATIONALE	More climate-related disasters mean more need for emergency response. The combination of higher risks and smaller communities, particularly in vulnerable regions, means that the need to respond may become more urgent but the ability to maintain emergency services locally is cost prohibitive. If response times can be reduced to support vulnerable populations then there have been steps made to identify vulnerable populations and to improve the methods of providing that support. This will make us more resilient to such disasters.
METRIC USED	Average speed of emergency response to an event focused on high-risk vulnerable populations (quantitative) [adapted from Siemens]
BASELINE	Number of emergency calls; average time to respond; length of call
CONTEXTUAL INFORMATION	More climate related disasters means more need for emergency response. The ability to respond may be hampered by the support system that is in place, including access to that support system, availability of information, lack of equipment, and training. This issue was raised in the Expert Panel discussions especially by remote Arctic communities, which are supported by Coast Guard and Canadian Forces bases in the south. "Emergency management in the Arctic is spread among a wide array of federal, territorial and municipal agencies.....Several branches of the Department of National Defense, the Coast Guard (Ministry of Fisheries and Oceans), the RCMP and the Government of Nunavut, as well as volunteer organizations such as the Canadian Coast Guard Auxiliary and community Search and Rescue teams all play a role. The primary mandate for marine and aerial search and rescue (SAR) belongs to the Department of National Defense (DND) with the support of the Canadian Coast Guard and the volunteers of the Coast Guard Auxiliary. SAR is administered through three Joint Rescue Coordination Centers (JRCCs) based across southern Canada ..... given the distance military/Coast Guard SAR technicians must travel from southern airbases to respond to Arctic emergencies and recognizing that northerners will respond to these disasters whether or not they have the appropriate expertise and equipment, the top priority of leaders in the Arctic is for their communities to be given adequate training, assets and resources to appropriately manage these emergency situations and support successful outcomes" (Benoit 2017). With equipment and training, local communities can be enabled to respond more quickly and be supported as need be by the larger capacity in other locations. Knowledge about vulnerable populations gathered in support of these indicators will allow more rapid identification of vulnerable peoples for emergency responders. Reducing the time for response will put fewer Canadians at risk and improve the outcomes for vulnerable populations. The indicator should be disaggregated by:

	• Type of response such as search and rescue, evacuation, medical support or 911. • 10 high-risk vulnerable populations: Locally- identified vulnerable populations • Hazard type, such as river flooding, shoreline flooding, stormwater flooding, wildfires, and permafrost thawing.
RELEVANCE FOR INDIGENOUS PEOPLES	As discussed in the context section, emergency response times for remote areas (which correlate with many Indigenous Peoples) will look different to emergency response times for urban areas, partly because the same emergency services are not available. Resources and funding must be directed to provide local training and resources to improve response time for climate-related emergencies in remote areas.
LIMITATIONS	We anticipate that data on response times for particularly smaller/voluntary EMS calls may be lacking in remote communities. Many sources available for data.
OVERLAP WITH OTHER CHAPTERS	This is related to Chapter 2: Protecting and Improving Human Health and Well-Being and Chapter 3: Supporting Particularly Vulnerable Regions. Infrastructure may also be impacted, to have the services in place to support quicker response times, specifically in remote areas. Therefore, there may also be overlap with Chapter 5: Building Climate Resilience through Infrastructure.
POTENTIAL DATA SOURCES	EMS organizations including municipal fire and police; Coast Guard, Department of National Defence, RCMP, provincial and territorial governments
REFERENCES/MORE INFORMATION	EMS organizations including municipal fire and police; Coast Guard, Department of National Defence, RCMP, provincial and territorial governments

29. Number of people directly affected by a climate-related disaster

FACTORS TO CONSIDER	
RATIONALE	Reporting the number of people directly impacted by climate-related disasters will be an indication of the amount of resources and financial support required to facilitate response and recovery efforts including the health sector, the extent of exposure to climate-related hazards. This reporting will also be indicative of the frequency and severity of disasters. The most important disaggregation of this indicator is by vulnerable group, such as Indigenous Peoples, to manage potential inequities in response and recovery which can occur during disaster events.
METRIC USED	Quantitative measures of: • People who have suffered injury, illness or other health effects; • Who were evacuated, displaced, relocated; or • Have suffered direct damage to their livelihoods, economic, physical, social, cultural and environmental assets.
BASELINE	Based on Sendai Framework and the baseline they have set.
CONTEXTUAL INFORMATION	Given the current level of exposure across Canada, the number of people directly affected by climate-related disasters will likely increase as the frequency and severity of disasters intensifies with a changing climate. However, this information is critical to assist in planning of emergency response, infrastructure, land use, essential services and financial supports. In the long term, as adaptation measures are implemented, this number should stabilize and hopefully start to decrease. The Sendai Framework looks at both direct and indirect impacts, but acknowledges the difficulty in measuring the indirect impacts. However, the trend in direct impacts should be indicative of the indirect impacts and planning needs to consider both. Excerpt from "Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets of the Sendai Framework for Disaster Risk Reduction" (UNISDR, 2017a): **Directly affected**: People who have suffered injury, illness or other health effects; who were evacuated, displaced, relocated; or have suffered direct damage to their livelihoods, economic, physical, social, cultural and environmental assets. **Indirectly affected**: People who have suffered consequences, other than or in addition to direct effects, over time due to disruption or changes in economy, critical infrastructures, basic services, commerce, work or social, health and physiological consequences. The indicator should be disaggregated by: • Vulnerable group: Indigenous Peoples, seniors, low-income residents, persons with low literacy levels, transient populations, persons with disability, medically dependent persons, children and youth, women, and

	new immigrants and cultural minorities. • Hazard type, such as river flooding, shoreline flooding, stormwater flooding, wildfires, and permafrost thawing. • Region such as coastal, northern, remote, prairies, mountains, urban, rural. • Type of impact such as evacuation, physical damage to property, physical health, etc.
RELEVANCE FOR INDIGENOUS PEOPLES	Indigenous Peoples are especially vulnerable to climate change and thus disaggregating this indicator by vulnerable group will show if adaptive measures are decreasing the impacts to those that are the most affected and least likely to recover from disasters.
LIMITATIONS	Although there are many challenges in accurately measuring all directly affected people, estimated and longer term trends in these estimates will provide valuable information to see if adaptive measures are reducing the number of directly affected people. This will also help to allocate appropriate resources to support the emergency response and recovery actions associated with these numbers.
OVERLAP WITH OTHER CHAPTERS	This is related to all chapters in this report. Number of people directly impacted by illness and physical harm will tie closely to health and well-being as well as the long term mental health impacts from temporary or permanent displacement. The number of people will also tie closely to damages associated with infrastructure. Vulnerable regions (coastal, northern and remote) also align with vulnerable populations in many cases, specifically Indigenous Peoples, and thus this will also show where impacts to specific regions, vulnerable populations and hazard types are improving or escalating. This information will help to prioritize adaptive action as priorities get reassessed. Additionally, as the number of people directly affected increases, knowledge and experience of communities will increase. This is also an opportunity to build knowledge and adaptive measures during recovery.
POTENTIAL DATA SOURCES	Existing indicator with the Sendai Framework
REFERENCES/MORE INFORMATION	UNISDR [United Nations International Strategy for Disaster Reduction] (2017a). *Technical Guidance for Monitoring and Reporting on Progress in Achieving the Global Targets of the Sendai Framework for Disaster Risk Reduction*. United Nations. Retrieved from https://www.unisdr.org/files/54970_techguidancefdigitalhr.pdf

30. Number of days for citizens to receive financial assistance (cash in hand) from time of application

FACTORS TO CONSIDER	
RATIONALE	The speed in which citizens receive financial assistance is a key metric associated with retention of community confidence needed to restore a level of normalcy post-disaster. Financial assistance can come from both public and private sectors.
METRIC USED	Quantitative
BASELINE	In Canada, the speed with which funds were delivered after cross-country flood events in 2017 can be aggregated by survey to provide a baseline.
CONTEXTUAL INFORMATION	Globally, the speed with which financial assistance is delivered can be correlated with community cohesion post-event. This indicator is also positively correlated with the maturity of the private insurance market as funds flow faster from private risk pools than from government-backed disaster relief efforts. Typically, for events which are well-insured such as wildfire in Canada, citizens see funds flow for rebuilding within months. For events which are not well insured, such as overland flooding in Canada, such rebuilding can take years and emigration out of affected areas can occur, affecting economic recovery post-event. Note that funds may be required in the very short term after an event. The indicator should be disaggregated by: • Hazard type, such as river flooding, shoreline flooding, stormwater flooding, wildfires, and permafrost thawing. • Region such as coastal, northern, remote, prairies, mountains, urban, rural. • Vulnerable population
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is particularly relevant for vulnerable communities, including Indigenous communities. Typically vulnerable communities have lower social resilience. This metric can be correlated with other metrics involving baseline and post disaster social measures related to mental health, and employment.
LIMITATIONS	This indicator should be correlated with an indicator that measures the percentage of losses reimbursed post event. Government reimbursement or insurance mechanisms that only provide a fraction of losses will not aid sufficiently in maintaining community cohesion. This indicator is particularly relevant for vulnerable communities, including Indigenous communities. Typically vulnerable communities have lower social resilience. This metric can be correlated with other metrics involving baseline and post disaster social measures related to mental health and employment.
OVERLAP WITH OTHER CHAPTERS	
POTENTIAL DATA SOURCES	• Post event surveys of claims payouts coordinated by the Insurance Bureau of Canada • Tracking of Disaster Financial Assistance claims/payout timing from federal and provincial programs
REFERENCES/MORE INFORMATION	• Correlated with indicator: Percentage of total financial losses restored, making citizens whole

31. Percentage of total financial losses restored, making citizens whole

FACTORS TO CONSIDER	
RATIONALE	The percentage of financial losses restored after an event is a direct metric of resilience.
METRIC USED	Quantitative
BASELINE	In Canada, given claims requested and granted from private and public funds after the 2017 nationwide floods, the average amount granted versus amount claimed can be aggregated as a baseline.
CONTEXTUAL INFORMATION	Given that Canadian citizens often have much of their financial wealth invested in their real property, this indicator is a direct measure of resilience. This indicator is also positively correlated with the maturity of the private insurance market as insurance funds are designed to '**make people financially whole'** whereas funds from public sources are only designed for partial compensation. If this metric trends positive over time, it indicates that resilience is increasing as partial compensation public risk pools give way to full compensation private risk pools. Typically, for events which are well-insured such as wildfire in Canada, citizens see full compensation for their claims. For events which are not well insured, or for which insurance products are poorly articulated, such as overland flooding in Canada, compensation percentages will be lower. Note that this metric may be disaggregated to measure improvements in private insurance coverage alone. The indicator should be disaggregated by: • Hazard type, such as river flooding, coastal flooding, stormwater flooding, wildfires, and permafrost thawing. • Region such as coastal, northern, remote, prairies, mountains, urban, rural.
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is particularly relevant for vulnerable communities including Indigenous Peoples who are more likely to be financially exposed. Should affected individuals only receive partial compensation, their overall financial health is more likely to be affected. This metric can be correlated with other metrics involving baseline and post disaster social measures related to mental health, and employment (loss of working days and of job status as a result of disruption to their livelihood).
LIMITATIONS	This metric can skew positive unless coupled with a metric showing speed of reimbursement. Should individuals receive full compensation years after an event, they may not be able to restore their livelihood and rebuild.
OVERLAP WITH OTHER CHAPTERS	This is related to Chapter 2: Protecting and Improving Human Health and Well-Being and Chapter 3: Supporting Particularly Vulnerable Regions in terms of individuals' ability to "make people financially whole" coupled with the time it takes to receive funds.
POTENTIAL DATA SOURCES	• Post event surveys of claims payouts coordinated by the Insurance Bureau of Canada • Tracking of Disaster Financial Assistance claim/payout amounts from federal and provincial programs
REFERENCES/MORE INFORMATION	• Correlated with indicator: Number of days for citizens to receive financial assistance (cash in hand) from time of event

Building Climate Resilience through Infrastructure

32. Percentage of communities (regional, municipal, Indigenous Peoples) with planning mechanisms that incorporate or consider climate resilience in community infrastructure development

FACTORS TO CONSIDER	
RATIONALE	This indicator seeks to demonstrate the extent to which climate resilience has become a standard part of community planning processes that directly influence how infrastructure is located, designed, built, operated, and maintained. This indicator would apply to both new and existing infrastructure; therefore, it would also apply to the re-location, retrofitting, and servicing of existing infrastructure.
METRIC USED	The metric selected is based on the percentage of all Canadian communities (regardless of size). The indicator can be disaggregated into percentage of communities in various size categories. This indicator relies on the percentage of communities that incorporate climate resilience into their planning mechanisms (as opposed to the percentage of the Canadian population). This is to ensure that we have a metric that is not overly biased or influenced by cities with larger populations. In aggregation, this indicator would include Indicator 12.
BASELINE	Establishing a baseline requires some key elements: • A reasonably clear standard for determining if a community's planning mechanisms incorporate climate resilience (e.g., through a climate risk assessment, a climate adaptation strategy, the community planning process, and through the design, location, construction, operation, maintenance, re-location, and retrofit of infrastructure). • A clear approach to count the number of communities that will be assessed in the metrics. Provinces, territories and Indigenous governing bodies may already have such inventories available. The following are examples of the types of landuse planning tools that could incorporate climate change adaptation considerations: • Official plans • Zoning bylaws • Land subdivision and development controls • Covenants and easements • Design guidelines • Environmental review of development projects • Indigenous planning mechanisms Recognizing that developing a climate adaptation process is a journey, the indicator can recognize that communities may be at different stages, such as: • Initiate: identifying stakeholders, establish a climate change adaptation team, etc. • Research: vulnerability and risk assessments, etc. • Planning: setting goals, objectives, action plans, etc. • Implement: funding of action plans, **implementation of planning**

	mechanisms • Monitor/Review: assess effectiveness and revise as appropriate Many communities are in the process of developing a climate resilience strategy and may not yet have climate resilience reflected in planning mechanisms. It is useful to have the baseline metrics reflect where on the journey a particular community is at.
CONTEXTUAL INFORMATION	It is critical that infrastructure is located and built in a manner that considers and incorporates adaptation to a changing climate. To do so effectively, climate resilience needs to be incorporated into the standard planning and development processes (e.g., into policies, bylaws, official plans and other planning mechanisms). It also needs to be across the full community, not just in certain pockets. In order for infrastructure to be located and built in a manner that is resilient to a changing climate a community needs to understand its potential hazards and vulnerabilities; e.g., through completing relevant climate change risk assessments. "It should also be acknowledged that even explicit mention of climate change adaptation does not guarantee an improved capacity to address the impacts of climate change. Furthermore, there may be adaptation actions happening, regardless of whether plans or policies have mentioned adaptation or not. Similarly, many planning documents are not prescriptive and may mention adaptation, but this does not mean adaptation is in fact happening on the ground." (source: ICLEI) Incorporation of climate resilience into the planning process may be evidenced by reference to codes and standards affecting built infrastructure that have been reviewed and updated as appropriate for a changing climate (to the extent that such standards have been updated).
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is applicable to all communities, including Indigenous Peoples, whether in urban, rural, or remote areas. Indigenous governing bodies may want to assess and track this indicator for their communities (using a self-assessment approach in a culturally appropriate manner). The phrase "planning mechanisms" was used in this indicator as opposed to "bylaws, policies, and official community plans" to ensure that Indigenous approaches to land use and community planning were also captured.
LIMITATIONS	This indicator relies on a reasonably clear standard for determining if community planning mechanisms incorporate climate resilience. Applying such a standard in a consistent manner could be challenging, and data collection for this indicator may rely on some self-reporting. Determining whether climate resilience was meaningfully incorporated (e.g., standardized) will also be a challenge. For instance, mention of the importance of addressing climate change in a policy or plan's preamble does not have the same impact as a specific requirement to re-direct new development away from flood-prone areas.
OVERLAP WITH	As steps to reduce vulnerabilities (e.g., climate risk assessments, specific planning

OTHER CHAPTERS	processes such as 'build back better') inform or relate to planning and impacts built infrastructure location, design, and development, and as updating planning mechanisms is essentially an 'action', this indicator relates to Chapter 4: Reducing Climate-Related Hazards and Disaster Risks and Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action.
POTENTIAL DATA SOURCES	Review of planning bylaws Interviews with local planning office Federation of Canadian Municipalities ICLEI Canada Provincial and territorial governments Indigenous governing bodies Intact Center for Climate Adaptation Ouranos
REFERENCES/MORE INFORMATION	British Columbia. A Guide to Green Choices: Ideas & Practical Advice for Land Use Decisions in British Columbia Communities (2008) http://www.cscd.gov.bc.ca/lgd/intergov_relations/library/BCMCD_AGuideToGreenChoices.pdf Clean Air Partnership. 2016. Clean Air Council 2015 – 2018 Inter-Governmental Declaration on Clean Air & Climate Change. Available online at: http://www.cleanairpartnership.org/wp-content/uploads/2016/10/Declaration-with-cover.pdf ICLEI Canada. Building Adaptive & Resilient Communities (BARC) program. Available online at: http://www.icleicanada.org/programs/adaptation/barc Prairie Climate Centre. Building a Climate-Resilient City research series. Available online at: http://prairieclimatecentre.ca/publications/ Risk Sciences International & Ontario Centre for Climate Impacts and Adaptation Resources. 2015. Climate Change Adaptation for Infrastructure and Planning: Case Studies. Available Online at: http://www.climateontario.ca/doc/workshop/AICCID/CaseStudyPresentation.pdf Urban Strategies. 2017. Getting Real About Climate Change in Planning Policy. Available online at: http://www.urbanstrategies.com/news/cc-policy/

33. Number of codes and standards reviewed, updated and developed across the full breadth of climate hazard types and asset types at risk, including Indigenous-specific building programs

FACTORS TO CONSIDER	
RATIONALE	This indicator tracks progress in reviewing, developing, and updating national codes and standards that guide how infrastructure is designed and built.
METRIC USED	Number of national codes, standards and Indigenous-specific building programs
BASELINE	The National Research Council and the Standards Council of Canada are already in the process of updating standards for climate resilience, and may be able to provide a first estimate of a baseline. The baseline could consist of: • A full inventory of all relevant existing codes and standards that affect built and natural infrastructure, categorized by (sub)sector. • Of the existing codes and standards, which ones have been reviewed to assess the need for updating for climate resilience, which ones are in the process of being updated, and which ones have already been updated for climate resilience. • What codes and standards do not yet exist that should be developed to ensure that built infrastructure is climate resilient.
CONTEXTUAL INFORMATION	Codes and standards directly influence how infrastructure is located, designed and built. In measuring this indicator, the National Research Council and the Standards Council of Canada would be relied upon in assessing what a climate resilient standard is (i.e., their assessment process would be viewed as being rigorous and reliable). It should be noted that there are climate resilient standards that have been, are being, or should be developed for the North (given the unique circumstances in the North). The Standards Council of Canada currently has three key work streams in its Infrastructure and Climate Change Program: • Stream 1 - Standardization guidance for weather data, climate information and climate change projections • Stream 2 - Updating existing infrastructure standards • Stream 3 - Phase 2 of the Northern Infrastructure Standardization Initiative
RELEVANCE FOR INDIGENOUS PEOPLES	Some codes and standards may be more relevant for certain Indigenous Peoples (e.g., standards specifically for the North) and some codes and standards may not be relevant at all. The nature of codes and standards as strict and uniformly-applied, engineering-based design principles may not be compatible with Indigenous approaches to infrastructure development and other ways of knowing. Later indicators (e.g., assessing the extent to which the standards are adopted and or reflected in codes) may therefore require some specific modifications for the Indigenous context. Indigenous Peoples may prefer to self-determine what constitutes "climate-resilient" for some types of infrastructure in their communities and develop culturally-appropriate building programs.
LIMITATIONS	Having a number of codes and standards that have been updated does not

	indicate priority and/or relative importance or influence across different types of standards. Disaggregation of the count (e.g., by sector) can help with interpreting the indicator for various uses. Ideally, this indicator would be expressed as a percentage of codes and standards that have been updated, but it would be difficult to have a definitive list and count of all relevant codes and standards.
OVERLAP WITH OTHER CHAPTERS	This indicator relates to the development and re-development 'build back better' control policies, bylaws, and regulatory tools for climate hazard areas, and relates to Chapter 4: Reducing Climate-Related Hazards and Disaster Risks.
POTENTIAL DATA SOURCES	CSA Group Infrastructure Canada Intact Center for Climate Adaptation National Research Council Northern Infrastructure Standardization Initiative Ouranos Standards Council of Canada
REFERENCES/MORE INFORMATION	Burns, Mike. 2016. *Standards Development for Northern Climates*. Available online at: https://adaptationcanada2016.ca/wp-content/uploads/2016/04/T2B-Burns.pdf CSA Group. 2017. *CSA Group Launches Initiative to Incorporate Climate Change Adaptation Into Seven Canadian Infrastructure Projects*. Available online at: https://www.csagroup.org/news_or_press/csa-group-launches-initiative-to-incorporate-climate-change-adaptation-into-seven-canadian-infrastructure-projects/ Infrastructure Canada. *2017-2020 Departmental Sustainable Development Strategy*. Available online at: http://www.infrastructure.gc.ca/pub/other-autre/dsds-smdd-2017-2020-eng.html International Institute for Sustainable Development. 2013. *Climate Change Adaptation and Canadian Infrastructure – A review of the literature*. Available online at: http://www.iisd.org/pdf/2013/adaptation_can_infrastructure.pdf Moudrak, N.; Feltmate, B. 2017. *Preventing Disaster Before It Strikes: Developing a Canadian Standard for New Flood-Resilient Residential Communities*. Prepared for Standards Council of Canada. Intact Centre on Climate Adaptation, University of Waterloo. Available online at: http://www.intactcentreclimateadaptation.ca/wp-content/uploads/2017/10/Preventing-Disaster-Before-it-Strikes.pdf National Research Council of Canada. 2018. *Climate-Resilient Buildings and Core Public Infrastructure* (CRBCPI). Available online at: https://www.nrc-cnrc.gc.ca/eng/achievements/highlights/2018/climate_resiliency.html Natural Resources Canada. *The National Building Code of Canada*. Available online at: http://www.nrcan.gc.ca/energy/efficiency/housing/new-homes/19845

	Ouranos. 2017. Standardization Guidance for Weather Data, Climate Information and Climate Change Projections – Overview of Canadian practices, needs and challenges on integrating climate change into infrastructure design. Available online at: https://www.scc.ca/sites/default/files/file_attach/SCCReport_Standardization_guidance_for_Weather_data_Climate_Change_Infor_Final_English.pdf Standards Council of Canada. *Infrastructure Program: Stream 3 - Phase 2 of the Northern Infrastructure Standardization Initiative* (overview). Available online at: https://www.scc.ca/sites/default/files/file_attach/Images/SSEB_RPT_Stream3_Program-Outline_NISI-Phase2-Final_2016-09-07_PR.pdf

34. Number of government procurement documents integrating climate resilience considerations into their requirements and specifications for infrastructure

FACTORS TO CONSIDER	
RATIONALE	This indicator tracks to what extent climate resilience is becoming a 'must have' in government procurement practices for infrastructure-related services and development.
METRIC USED	Number of procurement documents
BASELINE	Assessing a baseline could include: • Identification of the relevant federal, provincial, territorial, and municipal government departments that oversee procurement of infrastructure-related services and assets; • Assessing which government departments have to, as part of their climate change adaptation strategy, include climate resilient requirements and specifications; and • Data mining procurement documents to identify which ones have reference, in some form, to climate resilience.
CONTEXTUAL INFORMATION	Procurement requirements have a significant impact on the requirements or specifications for infrastructure. They may refer to climate-resilient codes and standards (to the extent that they exist). Also, once a given department or government makes climate resilience a standard in its procurement process, the propagation of relevant requirements is much easier. Thus, disaggregation is helpful to see in what contexts and at what levels of government there is more progress on climate-resilient procurement approaches.
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is relevant for Indigenous Peoples to the extent that Indigenous Peoples and relevant governing bodies rely on procurement processes to obtain infrastructure related services and assets. Depending on what is being procured, Indigenous Knowledge Systems may be relied upon in considering what would be considered to be climate resilient.
LIMITATIONS	This indicator may at first seem difficult to measure. However, this could simply be that 'climate resilience' requirements are not yet a standard in the procurement process. The aim is to get to a stage where such provisions are the norm. In the beginning, the indicator may simply be tracking a relatively small number of infrastructure-related procurement documents that incorporate climate resilience.
OVERLAP WITH OTHER CHAPTERS	None directly
POTENTIAL DATA SOURCES	Infrastructure Canada Infrastructure banks (federal, provincial) Provincial infrastructure departments Transport Canada Municipal procurement departments
REFERENCES/ MORE INFORMATION	British Columbia, Ministry of Transportation & Infrastructure. Technical Circular T-06/15: Climate Change and Extreme Weather Event Preparedness and Resilience in Engineering Infrastructure Design. Available online at: https://www2.gov.bc.ca/assets/gov/driving-and-transportation/transportation-infrastructure/engineering-standards-and-guidelines/technical-circulars/2015/t06-15.pdf

	British Columbia. *Guidelines for Environmentally Responsible Procurement.* Available online at: https://www2.gov.bc.ca/gov/content/governments/services-for-government/bc-bid-resources/reference-resources/green-procurement/guidelines-for-environmentally-responsible-procurement Government of Canada. *Public Services and Procurement Canada's Departmental Sustainable Development Strategy: 2017 to 2020*. Available online at: https://www.tpsgc-pwgsc.gc.ca/rapports-reports/smdd-dsds/index-eng.html Canada Infrastructure Bank. Available online at: http://canadainfrastructurebank.ca/ Government of Ontario. 2017. Building Better Lives: Ontario's Long-Term Infrastructure Plan 2017. Available online at: https://news.ontario.ca/moi/en/2017/11/long-term-infrastructure-plan-focused-on-building-ontario-up.html

35. Number of critical infrastructure in locally identified high-risk climate hazard areas

FACTORS TO CONSIDER	
RATIONALE	This indicator will seek to measure and monitor the number of assets deemed to be critical infrastructure that are located in high risk climate hazard areas (e.g., flooding, wildfire, permafrost thaw, etc.). This indicator will track if communities have stopped building new infrastructure in high risk areas, moved critical infrastructure out of a high risk area, or taken steps to mitigate the climate risk for that area. A declining number of structures and buildings exposed to locally-identified high climate risk will indicate enhanced resilience.
METRIC USED	Number of assets deemed to be critical infrastructure in locally identified high-risk climate hazard areas.
BASELINE	Require information on the number of assets deemed critical infrastructure and identification of high risk hazard areas.
CONTEXTUAL INFORMATION	The indicator measures number of assets deemed to be critical infrastructure as a proxy for a community's risk to climate impacts. Measuring the number of assets is much easier than attempting to quantify other exposures, such as population, property value, etc. The critical infrastructure classification will focus the community on adaptation measures given the impact on the community and the financial costs if such important assets fail, for example due to a flood event. A community can move the critical infrastructure to a lower risk area or take steps to make the area less risky from locally-relevant climate impacts. Areas prone to climate impacts need frequent assessment for risk level and a common standard for measuring the risk level, such as used in the property and casualty insurance industry. In addition, a common definition will be required for critical infrastructure. Critical infrastructure is defined as follows by Public Safety Canada: • **Critical infrastructure** refers to processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of Canadians and the effective functioning of government. Critical infrastructure can be stand-alone or interconnected and interdependent within and across provinces, territories and national borders. Disruptions of critical infrastructure could result in catastrophic loss of life, adverse economic effects and significant harm to public confidence. • Sectors related to critical infrastructure: ○ Health ○ Food ○ Finance ○ Water ○ Information and Communication Technology ○ Safety ○ Energy and utilities

	○ Manufacturing ○ Government ○ Transportation This indicator can be disaggregated by infrastructure category, as well as by region or province. Specifically, this indicator could be disaggregated by: • Critical infrastructure type such as electrical power, medical facilities, gas utilities, police, fire departments, etc. • Hazard type, such as river flooding, coastal flooding, storm water flooding, wildfires, and permafrost thawing. • Region such as coastal, northern, remote, prairies, mountains, urban, rural. • Can be complimented with number of critical infrastructure accounting for defenses. An objective of this indicator is to discourage continued infrastructure expansion in high risk areas and to encourage adaptive measures, such as moving critical infrastructure out of the area and/or building defenses that reduce the climate risk to existing assets in high risk areas. Such action would improve the response and recovery to climate impacts.
RELEVANCE FOR INDIGENOUS PEOPLES	Nearly all climate-related hazards are applicable to Indigenous Peoples. Focusing protection measures on critical infrastructure and essential services should be a priority. Vast areas of the North are in climate hazard areas and thus the solutions are more nuanced than solutions for consideration in urban centers and southern/central Canada.
LIMITATIONS	Indicator has likely not been developed. Aerial images and local information sources should be able to quantify the number of assets in high risk areas. Areas need to be mapped against the various risk levels. Efforts to reduce the relevant climate risk, such as through new infrastructure, can reduce the risk category. Definitions of critical infrastructure will be required and will vary by community.
OVERLAP WITH OTHER CHAPTERS	The location of critical infrastructure in climate hazard areas is foundational to understand the amount of exposure and where to prioritize actions, this indicator relates to Chapter 2: Protecting and Improving Human Health and Well-Being, Chapter 3: Supporting Particularly Vulnerable Regions, Chapter 4: Reducing Climate-Related Hazards and Disaster Risks, and Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action.
POTENTIAL DATA SOURCES	Canadian property and casualty insurance industry Public Safety Canada Industry sector associations Community climate risk and vulnerability assessments
REFERENCES/MORE	Government of Canada. *Natural Hazards of Canada*. Available online at:

INFORMATION	https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/ntrl-hzrds/index-en.aspx Public Safety Canada. 2014. *Action Plan for Critical Infrastructure (2014 – 2017)*. Available online at: https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/pln-crtcl-nfrstrctr-2014-17/index-en.aspx

36. Number of Canadian institutional investors that have integrated climate change adaptation or resilience considerations into their investment strategies

FACTORS TO CONSIDER	
RATIONALE	This indicator assesses to what extent institutional investors are integrating climate change adaptation into their investment strategies.
METRIC USED	Percentage of public sector assets under management (AUM) that disclose specifically how they are assessing climate change adaptation in their portfolio, particularly related to real assets (e.g., real estate, infrastructure).
BASELINE	A baseline could rely on an assessment of investor disclosures in line with the Financial Stability Board's Task-Force on Climate Related Financial Disclosures (TCFD), particularly related to physical risks. The baseline could track the portion of investors (expressed as % AUM) that provides meaningful disclosures related to physical risk and how the investor is addressing these risks. Institutional investors in this context could be broken down into: • Public sector pension funds • Canadian banks • Canadian insurance companies • Canadian asset managers
CONTEXTUAL INFORMATION	Investors can have an important influence on resilient infrastructure through: • Direct investments in Canadian infrastructure; and • Indirect investment through ownership/debt-financing of Canadian infrastructure service providers across various sectors (e.g., home building companies, construction companies, telecommunication companies, etc.). Thus, their public disclosure of how they assess and manage climate change physical risk (or lack thereof) is a meaningful indicator as to how mainstream (or not) climate resilience is in business and investment planning, including infrastructure, which generally has higher exposure to climate change hazards.
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is relevant to Indigenous Peoples insofar as Canadian institutional investors fund infrastructure projects for Indigenous Peoples.
LIMITATIONS	Most of these investors will have a large portion of their assets invested outside of Canada. Many would not be direct investors in infrastructure per se. That said, many could be invested in Canadian companies that are infrastructure service providers (e.g., construction companies, telecommunications companies, etc.)
OVERLAP WITH OTHER CHAPTERS	None
POTENTIAL DATA SOURCES	CPA Canada Non-governmental organizations Principles for Responsible Investment Responsible Investment Association of Canada Investor Disclosures (mandatory and voluntary) Asset Owners Disclosures Project
REFERENCES/MORE INFORMATION	Financial Stability Board's Task Force on Climate Related Financial Disclosures (TCFD) Recommendations. Available online at: https://www.fsb-tcfd.org/publications/final-recommendations-report/

	Nakhooda, S. and Watson, C. ODI. 2016. *Adaptation Finance and the Infrastructure Agenda*. Available online at: https://www.odi.org/sites/odi.org.uk/files/resource-documents/10489.pdf

37. Percentage of total government infrastructure spending directed to building resilience towards locally-identified high priority climate risks (as identified by community climate vulnerability assessments)

FACTORS TO CONSIDER	
RATIONALE	This indicator documents what portion of government infrastructure spending is directed to addressing priority climate vulnerabilities.
METRIC USED	The metric would be C/A where: A. The total annual government infrastructure spending (at the various federal/provincial/territorial/municipal levels) B. Identifying what are the high priority risks based on community climate risk assessments C. Identifying the annual amount of funding going towards mitigating or addressing these priority climate change vulnerabilities
BASELINE	The baseline would require the amounts A, B and C above for a given year
CONTEXTUAL INFORMATION	While there is significant funding being made available for low-carbon infrastructure, there needs to be sufficient attention on spending towards resilient infrastructure. This indicator is meant to focus specifically on spending on projects that are focused on adaptation. While this may include a rebuild or new infrastructure, that is both low-carbon and resilient, the key determining factor for inclusion in C above is that the project is addressing a priority vulnerability by reducing exposure or sensitivity or increasing resilience.
RELEVANCE FOR INDIGENOUS PEOPLES	Indigenous Peoples would be among the communities to which climate resilient infrastructure dollars would ideally flow.
LIMITATIONS	Much of the infrastructure spending on "priority risks" may represent a combination of both low-carbon and resilient infrastructure (e.g., there may be a significant portion of government funding for new public transit that is both low-carbon and resilient). It is difficult to identify which. This indicator does explicitly measure the proportion of high priority climate risk vulnerabilities that are being addressed, but it can be derived.
OVERLAP WITH OTHER CHAPTERS	The climate change risk assessments used to determine the priority areas relate to vulnerability assessments as referred to in Chapter 3: Supporting Particularly Vulnerable Regions, Chapter 4: Reducing Climate-Related Hazards and Disaster Risks, and Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action.
POTENTIAL DATA SOURCES	Infrastructure Canada Provincial/territorial infrastructure ministries Infrastructure banks (federal, provincial) Municipalities
REFERENCES/MORE INFORMATION	Engineers Canada. 2017. *Principles of Risk Assessment and Overview of the PIEVC Protocol*. Available online at: https://www.fraserbasin.bc.ca/_Library/CCAQ_BCRAC/BC_RAC_PG_Workshop_2017_PIEVC_Principles.pdf Felio, G. 2015. *Vulnerability and Adaptation of Transportation Infrastructure to*

	Climate Change. Available online at: http://conf.tac-atc.ca/english/annualconference/tac2015/s13/felio.pdf Feltmate, B and Thistlethwaite, J. 2012. *Climate Change Adaptation: A Priorities Plan for Canada*. Available online at: https://uwaterloo.ca/environment/sites/ca.environment/files/uploads/files/CCAP-Report-30May-Final.pdf City of Toronto. 2016. *Resilient City – Preparing for a Changing Climate Status Update and Next Steps*. Available online at: https://www.toronto.ca/legdocs/mmis/2016/pe/bgrd/backgroundfile-98049.pdf

38. Amount of investment ($) directed to critical and climate resilient infrastructure (as defined by the recipient community) for Indigenous Peoples, including telecommunications, transportation and energy infrastructure

FACTORS TO CONSIDER	
RATIONALE	This indicator documents financial investments into critical and climate resilient infrastructure for Indigenous Peoples. Often Indigenous Peoples are still lacking in some basic infrastructure or are in regions that are more exposed to the impacts of a changing climate (e.g., northern or coastal communities). Infrastructure investment in these communities must therefore be prioritized.
METRIC USED	The total dollar amount spent in a given year from all relevant sources (e.g., local governing bodies, provincial or territorial governments, federal government, infrastructure banks, etc.) on critical and climate resilient infrastructure for Indigenous Peoples.
BASELINE	Information on funding programs and how much is used from these programs; financial information from communities in northern, remote, and coastal regions; provincial/territorial financial information.
CONTEXTUAL INFORMATION	Since Indigenous Peoples are especially at risk of experiencing climate change impacts, fortifying infrastructure to be climate resilient must be a priority. Interruptions to essential infrastructure services (e.g., electricity) could be especially devastating.
RELEVANCE FOR INDIGENOUS PEOPLES	This indicator is especially relevant to Indigenous Peoples because there is already an infrastructure crisis in many Indigenous communities. Infrastructure that is being built or improved must factor in climate resilience. Analysis of overall climate preparedness of Indigenous Peoples must account for infrastructure that is already below standard. For example, there are unique challenges for First Nations reserve communities due to the issue of jurisdiction as well as funding complications (e.g., stacking rules). Furthermore, infrastructure standards set by the federal government are often sub-par on First Nations reserves, making existing infrastructure even more vulnerable to the impacts of climate change. In a more specific analysis, or if data from this indicator can be disaggregated, it may be important to distinguish which funding sources have restrictive stacking rules. Furthermore, disaggregation of funding into Indigenous, Northern, etc. could help distinguish disparities in relative funding amounts for north/south, Indigenous/non-Indigenous, etc.
LIMITATIONS	The way this indicator is measured (amount invested) will have to be disaggregated by region. For example, remote communities will have higher costs than communities that are rural but still northern. Without this step, the indicator will have less meaning.
OVERLAP WITH OTHER CHAPTERS	Chapter 3: Supporting Particularly Vulnerable Regions
POTENTIAL DATA SOURCES	ECCC, CIRNA, ISC and Infrastructure Canada for utilization of federal funding programs Provincial/territorial infrastructure ministries

	Infrastructure banks (federal, provincial)
REFERENCES/MORE INFORMATION	National Aboriginal Economic Development Board. 2016. *Recommendations on Northern Infrastructure to Support Economic Development*. Available online at: https://nnca.ca/sites/default/files/Recommendations%20on%20Northern%20Infrastructure%20to%20Support%20Economic%20Development.pdf National Aboriginal Economic Development Board. 2014. *Study on Addressing the Infrastructure Needs of Northern Aboriginal Communities*. Available online at: http://www.naedb-cndea.com/reports/northern-infrastructure-report.pdf Indigenous Services Canada. 2017. *First Nation community infrastructure*. Available online at: http://www.aadnc-aandc.gc.ca/eng/1100100010567/1100100010571 Infrastructure Canada. *Investing in Canada Plan*. Available online at: http://www.infrastructure.gc.ca/plan/about-invest-apropos-eng.html Indigenous and Northern Affairs Canada. 2018. *New Federal Funding to Strengthen Nunatsiavut's Capacity to Address Climate Change Impacts*. Available online at: https://www.canada.ca/en/indigenous-northern-affairs/news/2018/02/new_federal_fundingtostrengthennunatsiavutscapacitytoaddressclim.html Indigenous and Northern Affairs Canada. 2018. *New Canada-Nunavut Funding Agreement to Strengthen Nunavut's Capacity to Address Climate Change Impacts*. Available online at: https://www.canada.ca/en/indigenous-northern-affairs/news/2018/01/new_canada-nunavutfundingagreementtostrengthennunavutscapacityto.html British Columbia Ministry of Environment (The Arlington Group et al). 2013. *Sea Level Rise Primer – A toolkit to Build Adaptive Capacity on Canada's South Coasts*. Available online at: https://www2.gov.bc.ca/assets/gov/environment/climate-change/adaptation/resources/slr-primer.pdf

39. Percentage of total government infrastructure spending directed towards natural infrastructure

FACTORS TO CONSIDER	
RATIONALE	Infrastructure dollars have typically been dedicated to supporting the design and construction of traditional grey infrastructure. There is a growing recognition of the importance of green or natural infrastructure as an alternative or supplement to grey infrastructure This indicator demonstrates the relative importance given to natural infrastructure as a tool for climate adaptation as compared to grey infrastructure.
METRIC USED	The metric would be A/B (i.e., A expressed as a percentage of B) where: A. Total annual government spending on climate resilient natural infrastructure, and B. The total annual government infrastructure spending (at the various federal/provincial/territorial/municipal levels)
BASELINE	The baseline would require the amounts A and B above for a given year. The total spending on natural infrastructure should be those projects that have a specific climate resilience objective.
CONTEXTUAL INFORMATION	The use of natural infrastructure is accelerating in Canada as a potentially cost effective solution to providing infrastructure services for Canadian communities. This reflects that traditional and re-engineered assets such as roads, pipes, and water treatment plants require significant capital for construction, operations and maintenance, and can have adverse and costly effects on the environment. Natural infrastructure can provide more flexible infrastructure functions and an array of services. For example, healthy watersheds purify water and also mitigate many of the impacts of extreme precipitation which can result in flooding. Part of its flexibility is that it is typically more adaptive to environmental change than many of the concrete and steel forms of infrastructure. A related aspect is that natural infrastructure typically provides multiple simultaneous infrastructure functions and benefits, whereas concrete/steel infrastructure is often designed to be single-purpose. Examples can include engineered storm water wetlands that provide habitat or bioswales that filter and infiltrate runoff while cooling the air and providing habitat.
RELEVANCE FOR INDIGENOUS PEOPLES	Natural infrastructure can be as beneficial for Indigenous Peoples as it is for others. In addition, Indigenous Protected and Conserved Areas (IPCAs) are being identified by some Indigenous Peoples.
LIMITATIONS	Competition for grey infrastructure dollars with huge deficits and life cycle replacement timeframes. The isolation of funding specifically for natural infrastructure may be challenging in some situations (e.g., if a bioswale is one piece of a broader community development program); i.e., the additive value of natural infrastructure rather than their own projects.
OVERLAP WITH OTHER CHAPTERS	Use of natural infrastructure can support disaster risk reduction and provide health co-benefits, therefore this is related to Chapter 2: Protecting and Improving Human Health and Well-Being and Chapter 4: Reducing Climate-

	Related Hazards and Disaster Risks.
POTENTIAL DATA SOURCES	Infrastructure Canada Provincial or territorial infrastructure ministries Municipalities and local governing bodies Conservation authorities
REFERENCES/MORE INFORMATION	Environment and Climate Change Canada (2017) Canadian Environmental Sustainability Indicators: Canada's protected areas. Consulted on March 18, 2018 www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=478A1D3D-1 Canadian Broadcasting Corporation. 2017. First Nations to have greater role in parks: federal environment minister. Available online at: http://www.cbc.ca/news/canada/calgary/canada-parks-first-nations-role-catherine-mckenna-1.4021019

40. Percentage of communities (regional, municipal, Indigenous Peoples) that have natural and cultural asset management plans

FACTORS TO CONSIDER	
RATIONALE	This indicator demonstrates the relative importance of natural and cultural assets at the local community level in comparison to traditional or grey infrastructure in relation to building climate resilience.
METRIC USED	The metric is based on the percentage of communities (regardless of size). The indicator can be disaggregated into percentage of communities in various size categories. This indicator relies on the percentage of communities that have implemented natural and cultural asset management plans (as opposed to the percentage of the Canadian population). This is to ensure that we have a metric that is not overly biased or influenced by cities with larger populations.
BASELINE	The baseline is simply the count of number of communities that have a natural and cultural asset management plans and those that do not. The baseline could also track the implementation status of plans for those communities that have developed them.
CONTEXTUAL INFORMATION	Natural infrastructure can be integrated into our infrastructure planning and design via land use planning, asset planning and management, engineering, and urban design. To ensure the longevity and resilience of the natural systems we integrate, there is a need to consider these as assets of a community that require management and maintenance from time to time as well as incorporating consideration of future climate conditions (such as what sorts of species and ecosystems will thrive in those conditions). Natural assets valuation and forward-looking climate change scenarios should be incorporated into natural asset management plans. In doing so, capital and operational funding will be allocated to asset management to ensure that the natural assets continue to perform their functions as well as the built and grey infrastructure systems that are typically considered community assets. This indicator assumes that natural and cultural asset management plans are based on future climate projections, local climate vulnerability assessments, and an understanding of which types of ecosystems, vegetation, and cultural assets will withstand future climate conditions.
RELEVANCE FOR INDIGENOUS PEOPLES	Indigenous Peoples may draw on traditional ways of recognizing, valuing, preserving, and leveraging the natural environment (e.g., through Indigenous Protected and Conserved Areas (IPCAs)). This is also the case for cultural assets.
LIMITATIONS	Natural and cultural assets are not currently inventoried. The methodologies to value natural assets as part of asset management process are an evolving area of work. Process to consistently adopt verified or certified natural asset valuations into an asset management program for implementation at the municipal level.
OVERLAP WITH	N/A

OTHER CHAPTERS	
POTENTIAL DATA SOURCES	Municipal asset managers Public Sector Accounting Board Federation of Canadian Municipalities (FCM) Resource managers (Conservation authorities Ontario) Indigenous Peoples
REFERENCES/MORE INFORMATION	Canadian Parks Council. *Aboriginal Peoples and Canada's Parks and Protected Areas*. Available online at: http://www.parks-parcs.ca/english/pdf/aboriginal/intro%20and%20preface%20ENG.pdf Lane, J. Regional Municipality of York. 2017. *Managing Green Infrastructure as a Municipal Asset*. Available online at: http://greeninfrastructureontario.org/wp-content/uploads/2017/10/Presentation-GIO-Asset-Management-Workshop-YR-Case-Study-2017-09-15.pdf Park People. 2017. *Resilient Parks, Resilient City - The role of green infrastructure and parks in creating more climate-adaptive cities*. Available online at: https://parkpeople.ca/wp-content/uploads/2017/07/Resilient-Parks-Resilient-City_Park-People-1.compressed.pdf Sawka, M. Green Infrastructure Ontario Coalition. 2017. *A Roadmap for Green Infrastructure in Ontario*. Available online at: http://cleanairpartnership.org/cac/wp-content/uploads/2017/05/GIO-CAC-2017.pdf Smart Prosperity Institute. Municipal Natural Assets Initiative. 2017. *Defining and Scoping Municipal Natural Assets*. Available online at: http://institute.smartprosperity.ca/sites/default/files/finaldesignedsept18mnai.pdf Town of Gibsons. 2018. *Gibsons' Natural Asset Management Journey*. Available online at: http://gibsons.ca/sustainability/natural-assets/gibsons-natural-asset-management-journey/

41. Number of days of disruption to basic services and critical infrastructure

FACTORS TO CONSIDER	
RATIONALE	The health and well-being of a community is reliant on basic services and associated critical infrastructure required for delivering these services. Where and how critical infrastructure is built, and what emergency response measures are implemented, will reduce the potential for disruptions to basic services. Adaptive measures should be taken to prevent any disruption to basic services and associated critical infrastructure. Inadequacies in these basic services for Indigenous Peoples and vulnerable regions should be prioritized ahead of enhancing these services for other communities.
METRIC USED	Measurement of days of disruption to basic services and critical infrastructure due to a climate-related disaster event or slow-onset changes due to climate change.
BASELINE	An inventory of critical infrastructure and basic services being provided. The number of days of basic services and critical infrastructure were disrupted in year 1 of the indicator being measured.
CONTEXTUAL INFORMATION	Public Safety Canada defines critical infrastructure as: • **Critical infrastructure** refers to processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of Canadians and the effective functioning of government. Critical infrastructure can be stand-alone or interconnected and interdependent within and across provinces, territories and national borders. Disruptions of critical infrastructure could result in catastrophic loss of life, adverse economic effects and significant harm to public confidence. • Sectors related to critical infrastructure: ○ Health ○ Food ○ Finance ○ Water ○ Information and Communication Technology ○ Safety ○ Energy and utilities ○ Manufacturing ○ Government ○ Transportation Some essential items to consider include major transportation routes, power and telecommunication networks, water and wastewater infrastructure, medical facilities, schools, child care centers, senior citizen facilities, support centers for various vulnerable groups, and so forth. The indicator could be disaggregated by: • Type of basic service and critical infrastructure • Hazard type, such as river flooding, coastal flooding, stormwater flooding, wildfires, and permafrost thawing. • Region such as coastal, northern, remote, prairies, mountains, urban, rural.

	- Vulnerable group: Indigenous Peoples, seniors, low-income residents, persons with low literacy levels, transient populations, persons with disability, medically dependent persons, children and youth, women, and new immigrants and cultural minorities.
RELEVANCE FOR INDIGENOUS PEOPLES	Challenges already exist in the availability and reliability of essential services and critical infrastructure for Indigenous Peoples. Federal funding should first prioritize that essential services and critical infrastructure are available and reliable for Indigenous Peoples before directing funds to other communities to enhance these services to be resilient to climate-related disasters.
LIMITATIONS	Accurate and reliable reporting of these disruptions, particularly in light of different expectations and tolerances related to service disruptions in various part of the country.
OVERLAP WITH OTHER CHAPTERS	Chapter 4: Reducing Climate-Related Hazards and Disaster Risks In addition to designing, building and locating critical infrastructure with climate resilience in mind, effective early warning systems and emergency response are essential to reducing the days in which critical infrastructure is offline. Chapter 2: Protecting and Improving Human Health and Well-Being Medical centers and support services are critical during times of disaster, making their design and location in relation to impacts from climate-related disasters a critical consideration. Chapter 3: Supporting Particularly Vulnerable Regions Coastal, northern and remote areas may already be lacking in some of these basic services and this must be addressed first. How these areas respond in a climate-related disaster may differ from more urban centers and the services and infrastructure to support emergency response must also be included.
POTENTIAL DATA SOURCES	Public Safety Canada Industry associations (e.g., Canadian Electricity Association's SAIDI and SAIFi tracking)
REFERENCES/MORE INFORMATION	

42. Number of infrastructure operation and maintenance plans that have integrated climate resilience considerations

FACTORS TO CONSIDER	
RATIONALE	This indicator focuses on operational and maintenance approaches to climate change adaptation. In addition to design and planning, maintenance and operation are important for ensuring that Canada is prepared for more extreme events and the changing frequency and severity of otherwise normal events. This indicator could be relevant to existing infrastructure, and to ensure that infrastructure continues to meet relevant climate-resilient standards throughout the course of its lifetime.
METRIC USED	The number of operation and maintenance plans that have been reviewed and updated to incorporate climate change considerations
BASELINE	This metric is limited (for now) to infrastructure assets overseen by a given municipality or governing body.
CONTEXTUAL INFORMATION	Maintenance and operations are a critical component of the infrastructure lifecycle. Bridges, roads, storm water management, etc. all need to be monitored for necessary routine repair, major rehabilitation or alterations. Further, operations staff need to be trained to understand the changing climate conditions and how they may affect the infrastructure and related services.
RELEVANCE FOR INDIGENOUS PEOPLES	Indigenous Peoples may or may not have operation and maintenance plans in place for infrastructure within their communities.
LIMITATIONS	Given the potentially granular level of the data collection would be challenging if the relevant information is not already being captured in the asset management plan. As municipal asset management planning and climate resilient considerations become more common, the indicator will be more easily tracked and more meaningful.
OVERLAP WITH OTHER CHAPTERS	Potentially related to Chapter 6: Translating Scientific Information and Indigenous Knowledge into Action
POTENTIAL DATA SOURCES	Municipal asset management plans Indigenous Peoples
REFERENCES/MORE INFORMATION	Ontario Ministry of Infrastructure. 2017. *Update on Municipal Asset Management Planning*. Available online at: http://www.mfoa.on.ca/mfoa/main/pdfs/AC17_Wed_Sept20_Asset_Management_Herridge_Wilson_Barrett.pdf Union of Nova Scotia Municipalities. *The Basics of Asset Management*.

43. Number of infrastructure owners and operators that have integrated climate resilience into their planning, infrastructure investments, operations and strategy

FACTORS TO CONSIDER	
RATIONALE	Both public and private companies provide important infrastructure services in various sectors (e.g., telecommunications, power, energy distribution, transportation, etc.). The infrastructure services supported by these companies will only be climate resilient if the companies are planning and investing appropriately.
METRIC USED	The number of organizations (or percentage) in relevant sectors, such as the following, that disclose a reasonably robust climate change adaptation strategy (e.g., in line with the TCFD recommendations): • Energy • Transportation • Healthcare • Telecommunications • Utilities • Real estate
BASELINE	Climate change related public disclosure
CONTEXTUAL INFORMATION	Climate resilience is not only relevant to planning and design, but also to operation and maintenance. Private sector companies that provide infrastructure services need to be prepared for more extreme events and the changing timing of otherwise normal events. The UK Climate Change Act 2008 requires infrastructure operators and public bodies to report on how they are addressing current and future climate effects to their organisations. It captures the following sectors: • Aviation • Electricity distribution and transmission • Electricity generation • Gas distribution and transportation • Ports and lighthouses • Public bodies • Regulators • Road and rail • Water
RELEVANCE FOR INDIGENOUS PEOPLES	To the extent that a given community relies on these organizations to provide infrastructure services, the community would benefit from organizational preparedness.
LIMITATIONS	The current state of climate change adaptation related disclosure may be limited, but it is evolving. Industry associations may be best placed to support members in developing and disclosing relevant information on climate change adaptation plans to support infrastructure resilience. Changes within an industry sector may also rely on government standards and

	community planning mechanisms (rather than relying on relevant sectors to voluntarily do now what is best for all in the future).
OVERLAP WITH OTHER CHAPTERS	N/A
POTENTIAL DATA SOURCES	CPA Canada Industry associations Public disclosures (e.g., CSR/sustainability reports, strategy documents, surveys)
REFERENCES/MORE INFORMATION	Canadian Electricity Association. *Climate Change Adaptation*. Available online at: https://electricity.ca/lead/protecting-our-environment/climate-change-adaptation/ Ontario Chamber of Commerce. 2017. *BUILDING BETTER: Setting up the Next Ontario Long-Term Infrastructure Plan for Success*. Available online at: http://www.occ.ca/wp-content/uploads/Building-Better-Aug-23-1.pdf SFU Adaptation to Climate Change Team. 2017. *Taking Action on Green Resilience: Climate Change Adaptation and Mitigation Synergies*. http://summit.sfu.ca/system/files/iritems1/17658/taking_action_on_gr2017.pdf

Translating Scientific Information and Indigenous Knowledge into Action

44. Number of community-based climate-related monitoring and adaptation programs that include Indigenous, local and scientific knowledge

FACTORS TO CONSIDER	
RATIONALE	This indicator seeks to track the community level programs that explicitly include information and knowledge from different sources. Community monitoring programs are important to help get people involved in observing changes, understanding them, and subsequently acting upon them. These programs can also help to fill gaps in government-sponsored networks for data collection, which are not currently providing comprehensive coverage of climate change impacts and trends in Canada. They can also provide useful information to researchers and to groups in other locations, both in Canada and around the world, working on adaptation to changes that may be related to specific projects. These programs must be informed by and begin with concerns and interests expressed at local levels, and must also be based on robust sources of knowledge and robust methodologies, to ensure that what is being monitored is helpful to advance understanding of the changes, and that appropriate data collection and storage methods are used.
METRIC USED	Number of monitoring and adaptation programs that are community-based and explicitly include different types of knowledge.
BASELINE	Requires clear definition of what a monitoring and an adaptation program includes. Number of community-based monitoring and adaptation programs that include different sources of knowledge/total number of community-based monitoring and adaptation programs. Can also include: Number of adaptation programs and/or platforms promoting culturally sensitive and ethically appropriate data collection and analysis.
CONTEXTUAL INFORMATION	Knowledge and solutions should be co-produced with users, and cognizant of priorities identified in the host area. Working collaboratively to both co-create and disseminate knowledge on impacts and solutions is essential, since it is more likely to be used and implemented if knowledge users, knowledge holders, local experts and stakeholders participate in their development. Playing an active role in helping to produce the knowledge will make people more inclined to use it. The gathering and incorporation of local observations and Indigenous Knowledge Systems are essential components of the data collection process (Environment and Climate Change Canada, 2016), enabling the production of tools and other

	resources to support potential responses to these risks or opportunities, including actions such as identification of community values, planning, policy development, and implementation. This indicator suggests that communities have already identified climate change related issues of concern for their area.
RELEVANCE FOR INDIGENOUS PEOPLES	Seeks to measure those programs that include Indigenous Knowledge Systems.
LIMITATIONS	It may be difficult to track all community-based monitoring efforts since there is not one group that does this kind of activity. It may be challenging to assess the extent of geographic coverage without detailed program information. A baseline on the existing monitoring and adaptation programs does not exist at the moment and would be required to then track the ones that specifically include different sources of knowledge. Further challenging efforts to develop a baseline for this indicator, some adaptation programs may include all knowledge bases but may not explicitly mention that in their descriptions.
OVERLAP WITH OTHER CHAPTERS	Chapter 2: Protecting and Improving Human Health and Well-Being Chapter 3: Supporting Particularly Vulnerable Regions Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 5: Building Climate Resilience through Infrastructure
POTENTIAL DATA SOURCES	Government (e.g., federal, territorial, provincial, municipal, Indigenous) support for monitoring programs (including Health Canada, Crown-Indigenous Relations and Northern Affairs Canada, Department of Indigenous Services Canada, Environment and Climate Change Canada, Natural Resources Canada) National entities (Federation of Canadian Municipalities, Inuit Tapiriit Kanatami, Assembly of First Nations, Métis National Council, etc.) that play a role in supporting communities to develop such plans
REFERENCES/MORE INFORMATION	Alexander, C., Bynum, N., Johnson, E., King, U., Mustonen, T., Neofotis, N. O., Rosenzweig, C., Sakakibara, C., Shadrin, V., Vicarelli. M., Waterhouse, J., Weeks, B. (2011). Linking Indigenous and Scientific Knowledge of Climate Change. *BioScience*. 61(6). 477-484.

45. Amount of federal, territorial/provincial or municipal funds invested in development of up to date, accessible, relevant, co-produced, localized, equitably distributed information on climate and environmental data for both regions and sectors that can be used to support planning and decision making

FACTORS TO CONSIDER	
RATIONALE	This indicator seeks to track the funding allocated to developing and making accessible information on climate change to support planning and implementing adaptation actions. Sustained funding that is made available to a variety of data producers, and provided through programs that ensure equality in project design, is essential to development of relevant, up-to-date, adequately detailed data.
METRIC USED	Amount ($) (funding available from federal, territorial/provincial, or municipal governments to produce and disseminate this kind of information)
BASELINE	Total federal, territorial/provincial or municipal $ spent on developing and disseminating climate and environmental data
CONTEXTUAL INFORMATION	In order for Canadians to build and improve resilience to climate change impacts, it is essential to continually develop and update climate change information that can inform adaptation strategies and action, and that we plan, create and position these resources in forms and formats that can be used by the wide variety of audiences that must plan for climate change adaptation. Comprehensive, standardized environmental monitoring data that covers all regions in accessible formats to build knowledge is needed (e.g., base mapping flows, property, aerial photos, social vulnerability mapping, rain and flow gauges, weather/climate stations).
RELEVANCE FOR INDIGENOUS PEOPLES	Indicator includes attention to co-production, accessibility of funds, local specificity, and could reflect Indigenous Knowledge Systems and culturally relevant programs.
LIMITATIONS	Data must be updated regularly to remain relevant in a scientific field that is progressing at a rapid rate, a process that requires long-term monitoring, data gathering, and analysis. Consistent data collection processes would need to be used for successive years to ensure the metric maintains its validity. There may be cycles of investment as different types of data are re-analyzed, such as re-mapping of vegetation. This measure would need agreement on terms such as accessible and consistent. Not all data collected would need national coverage.
OVERLAP WITH OTHER CHAPTERS	This indicator relates to Chapter 2: Protecting and Improving Human Health and Well-Being, Chapter 3: Supporting Particularly Vulnerable Regions, Chapter 4: Reducing Climate-Related Hazards and Disaster Risks, and Chapter 5: Building Climate Resilience through Infrastructure, which identify the challenges that require a knowledge base and knowledge products in order to implement adaptation actions; however, none of them specify the need for funding.
POTENTIAL DATA SOURCES	Canadian Centre for Climate Services, along with regional climate consortiums, can provide information in terms of the extent of area covered by this kind of

	information. National organizations can track whether different groups have access to this information (Federation of Canadian Municipalities, Inuit Tapiriit Kanatami, Assembly of First Nations, Métis National Council etc.). Federal funding agencies can track how their funding is allocated. Environment and Climate Change Canada can track what other funds may be being made available at other levels of governance.
REFERENCES/MORE INFORMATION	

46. Number of adaptation-related research, knowledge and action materials and resources developed across themes and sectors for climate change

FACTORS TO CONSIDER	
RATIONALE	Climate change is a complex and quickly evolving issue. It is important to keep developing knowledge to help inform action. Knowledge development and the various tools and other resources that result from it are a demonstration of the packaging and communication required to advance action on climate change in Canada. This indicator seeks to track how much knowledge and how many resources are developed to support action across all themes and sectors.
METRIC USED	Number of resources for adaptation across themes and sectors
BASELINE	Need to establish what is to be included in research, knowledge, and action materials and resources. The following indicators could be included to help track this information: • Number of different topics covered by academic publications on adaptation • Number of academic publications on adaptation working with multiple ways of knowing • Number of defensible, standardized adaptation planning tools, policies and guidelines developed to inform decisions and recommended actions • Percentage of provinces and territories with access to up-to-date climate services tailored to local circumstances
CONTEXTUAL INFORMATION	In order for Canadians to build and improve resilience to climate change impacts, it is essential to continually develop and update climate change information, and tools, and products that can guide adaptation strategies and action. It is important to plan, create, and position these resources in forms and formats that can be used by the wide variety of audiences that must plan for climate change adaptation.
RELEVANCE FOR INDIGENOUS PEOPLES	Those resources that are developed with/by Indigenous Peoples; those resources that are developed specifically for Indigenous Peoples.
LIMITATIONS	The total amount of materials and resources may be significant; inability to track at various levels; the breadth of material covered in categories of 'research, knowledge, and action'.
OVERLAP WITH OTHER CHAPTERS	Chapter 2: Protecting and Improving Human Health and Well-Being Chapter 3: Supporting Particularly Vulnerable Regions Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 5: Building Climate Resilience through Infrastructure
POTENTIAL DATA SOURCES	Research funding organizations across all levels of government; knowledge brokers/boundary organizations; federal, territorial/provincial, or municipal governments; Indigenous governments and organizations
REFERENCES/MORE INFORMATION	All boundary organizations in Canada Ospina, A. V. (2017, November 18). *Tracking adaptation: Linking research, policy and action* [Web log post]. International Institute for Sustainable Development. Retrieved from https://www.iisd.org/blog/tracking-adaptation-linking-research-policy-and-action

	Ford, J. D., Berrang-Ford, L. (2015). The 4 Cs of tracking adaptation. *Mitigation and Adaptation Strategies for Global Change*. 21(6). 839-859. Tracking Adaptation to Climate Change Consortium (http://trac3.ca/).

47. Number of codes and standards developed that refer to, or address climate change and adaptation

FACTORS TO CONSIDER	
RATIONALE	This indicator seeks to track the existence, and new development, of codes and standards that provide guidance on best practices designed to factor climate change into crucial aspects of Canadian development and other infrastructure and economic activity. The codes and standards provide development requirements that account for current and future climate change so as to limit risks from events such as flooding, extreme heat, wildfires, and other challenges. Codes and standards are a clear demonstration of the transfer of scientific information to action to support climate change adaptation.
METRIC USED	Number of codes and standards that account for climate change
BASELINE	Total number of climate-sensitive codes and standards
CONTEXTUAL INFORMATION	Standards help to establish good practices and are widely used in different regions and in different sectors. Several already refer to climate information, but many areas of practice currently lack formal guidance for professional and best practices.
RELEVANCE FOR INDIGENOUS PEOPLES	Codes and standards can be applied in all areas and sectors.
LIMITATIONS	A clear definition of what constitutes a code and standard is needed, with implications for tracking given the breadth of codes in Canada. Codes and standards are often updated on 5 year cycles, so measurable increases may not be consistent over time.
OVERLAP WITH OTHER CHAPTERS	Chapter 2: Protecting and Improving Human Health and Well-Being Chapter 3: Supporting Particularly Vulnerable Regions Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 5: Building Climate Resilience through Infrastructure
POTENTIAL DATA SOURCES	Standards Council of Canada Accredited standards organizations in Canada
REFERENCES/MORE INFORMATION	

48. Number of training or capacity building programs that demonstrate the application of Indigenous Knowledge Systems and/or scientific information in the context of climate change adaptation

FACTORS TO CONSIDER	
RATIONALE	This indicator measures the number of training and capacity-building programs for climate change adaptation which explicitly use Indigenous Knowledge Systems and/or scientific information. Such programs are essential for development of expertise on adaptation at all points along the chain from knowledge to action, including planning, decision-making, funding, implementation, operations, and maintenance. The inclusion of different types of knowledge for such programs is also essential in order to ensure that adaptation approaches are accessible, relevant, and appropriate for different groups, and that different worldviews and their conceptualization of adaptation and its solutions are represented.
METRIC USED	Number of training and capacity-building programs that demonstrate the application of different sources of knowledge for climate change adaptation.
BASELINE	Total number of capacity-building programs on climate change adaptation. Other indicators to help track this information include: • Number of programs offering training on the land for young Canadians • Number of educational offerings, including within existing programs, providing adaptation training (school boards and universities could track) • Number of boundary organizations working on adaptation knowledge development and translation
CONTEXTUAL INFORMATION	Training to build adaptive capacity is considered necessary as part of adaptation readiness (Ford & Berrang-Ford, 2015).
RELEVANCE FOR INDIGENOUS PEOPLES	Indicator references Indigenous Knowledge Systems and could include training or capacity building programs that demonstrate cultural relevance
LIMITATIONS	Data collection processes would need to be used for successive years to ensure the metric maintains its validity.
OVERLAP WITH OTHER CHAPTERS	Chapter 2: Protecting and Improving Human Health and Well-Being Chapter 3: Supporting Particularly Vulnerable Regions Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 5: Building Climate Resilience through Infrastructure
POTENTIAL DATA SOURCES	Federal, provincial, territorial, and municipal government support for capacity-building projects
REFERENCES/MORE INFORMATION	Ford, J. D., Berrang-Ford, L. (2015). The 4 Cs of tracking adaptation. *Mitigation and Adaptation Strategies for Global Change*. 21(6). 839-859.

49. Percentage of Canadian professionals across sectors who have training in adaptation

FACTORS TO CONSIDER	
RATIONALE	This indicator measures the number of Canadian professionals across sectors who have training in climate change adaptation approaches, actions, and best practices. Measuring the uptake of climate information in professional practice across sectors could reveal key insights into progress, and encourage more widespread uptake of climate change knowledge, strategies, and best practices. Given that there are hundreds of thousands of professionals engaged in all aspects of Canadian society, advancing best practices and accredited continuous training programs for each profession has the potential to widely embed adaptation, and therefore resilience to climate change impacts, across all sectors of society. Professional development and learning in climate change adaptation is a sign that knowledge is being transferred to support action.
METRIC USED	Must establish what is considered training on climate change and adaptation (standard for minimum content). Number of professionals within key national and provincial professional associations (such as provincial planning institutes, forestry, agriculture, landscape architecture and engineering associations, etc.) compared with number of members who have taken courses or received accreditation in climate change adaptation offerings. It could also potentially be calculated by determining how many professional associations obtained/requested training from boundary organizations such as Ouranos, SFU-ACT, OCCIAR and PCIC.
BASELINE	The baseline is the total number of professionals that are members of professional associations. This is to get a sense of the potential number of professionals that could receive training and could be provided at different scales. In addition, we could track the number of adaptation-related training programs and/or accredited courses being developed and/or offered by professional associations.
CONTEXTUAL INFORMATION	Professionals play a key role in the uptake of climate action through their client base, best practices, professional associations, and networks. There are hundreds of thousands of professionals across Canadian sectors, with enormous cumulative influence in all aspects of land and water use. Most professional associations require a certain amount of training credits yearly to remain a member of the association for continued professional development purposes – this is also a tremendous leverage for getting climate change information into practices. If training on adaptation best practices is advanced across a wide variety of professions, there is potential for widespread adaptation implementation.
RELEVANCE FOR INDIGENOUS PEOPLES	
LIMITATIONS	Relationships and processes that can enable measurement need to be

	established to enable aggregation of data across sectors. Training and best practices for adaptation are not yet extensively developed so scrutiny of this indicator or potentially requiring demonstration of progress could incent action.
OVERLAP WITH OTHER CHAPTERS	Chapter 2: Protecting and Improving Human Health and Well-Being Chapter 3: Supporting Particularly Vulnerable Regions Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 5: Building Climate Resilience through Infrastructure
POTENTIAL DATA SOURCES	Professional associations and national and sub-national levels. Could also include professional practitioner associations. Organizations that provide training on climate change. Federal government departments could work with professional associations to develop/support training programs and then track the number of professionals that have taken the training. Ideally, this training could become mandatory for some professions to be considered an active member of a given association.
REFERENCES/MORE INFORMATION	

50. Extent of each province and territory covered by adaptation plans incorporating climate risk assessments, designed to be updated every 5 years

FACTORS TO CONSIDER	
RATIONALE	This indicator seeks to track the extent of coverage of adaptation plans developed across Canada. This will indicate how prevalent and integrated adaptation plans with climate risk assessments are in Canada. Measuring this by spatial coverage is useful because it will reveal large areas that may not be covered by localized municipal adaptation plans and/or may be sparsely populated, but may face significant risks – for instance, remote rural areas and the North as well as agricultural and coastal areas.
METRIC USED	Area of each province and territory covered by knowledge-based plans and kept up to date.
BASELINE	Total area and area covered by adaptation plans (or that include adaptation within existing plans?). This will require a description of a standard climate change adaptation plan (and what is included as an adaptation plan, e.g., adaptation strategies and actions embedded within other plans). The plans should include hazard, vulnerability, and risk assessments; acute and incremental changes, and cumulative impacts. It is essential to keep these plans up to date (e.g., plans should explicitly mention the process for revision). The following specific sub-categories of indicators could be included to help track this information: • Number of Indigenous-led plans • Number of youth-led plans • Number of community and regional government plans • Number of industry plans (hectares covered allows for rural/northern regions and industries such as agriculture and forestry) • Number of national industry association plans
CONTEXTUAL INFORMATION	It is evident that awareness is not sufficient — people must both care enough to act (Moser, 2014; Moser, 2016) and have the capacity to do so (Ford, 2015). This is especially important because climate science has become more specialized and fragmented by various groups of experts, and the gap is widening between experts and non-experts (including politicians and decision-makers). This gap between science producers and science users makes it more difficult to move from climate change science to climate change action (Naustdalslid, 2011). Climate risk assessments are important tools for understanding the issues more comprehensively and to prioritize actions. Adaptation plans should be based on an initial risk assessment.
RELEVANCE FOR INDIGENOUS PEOPLES	The indicator could motivate more regional coordination (or a regional approach) of adaptation planning within Traditional territories.
LIMITATIONS	Those plans that may not include clauses or conditions requiring updating every 5

	years would not be accounted for but still have value in demonstrating the use of different knowledge sources to inform action.
OVERLAP WITH OTHER CHAPTERS	Chapter 2: Protecting and Improving Human Health and Well-Being Chapter 3: Supporting Particularly Vulnerable Regions Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 5: Building Climate Resilience through Infrastructure
POTENTIAL DATA SOURCES	Provinces and territories, Federation of Canadian Municipalities, Inuit Tapiriit Kanatami, Assembly of First Nations, Métis National Council
REFERENCES/MORE INFORMATION	Ford, J. (2015). A framework for examining adaptation readiness. *Mitigation and Adaptation Strategies for Global Change*, 20(4), 505-526. Moser, S. (2014). Communicating adaptation to climate change: the art and science of public engagement when climate change comes home. Wiley Interdisciplinary Reviews: *Climate Change*, 5(3), 337-358. Moser, S. (2016, May 9). *Communicating impacts and adaptation.* [Video File]. Video posted to https://www.youtube.com/watch?v=GqgCL-hI8gY Naustdalslid, J. (2011). Climate change – the challenge of translating scientific knowledge into action. *International Journal of Sustainable Development & World Ecology* 18(3), 243-252.

51. Percentage of communities (including youth) implementing actions that support adaptation or increase resilience

FACTORS TO CONSIDER	
RATIONALE	This indicator seeks to track the extent to which communities are taking action to adapt to changing climate conditions.
METRIC USED	Percentage of communities that are implementing adaptation actions
BASELINE	Total number of communities
CONTEXTUAL INFORMATION	An increasing number of people at all levels and across all sectors are becoming concerned about climate change impacts and are seeking resources that can both help them envision the challenges in ways that relate to their specific needs, and help them develop solutions. For a complex issue such as climate change, these groups require knowledge-based processes in order to advance action on adaptation. It is also important to measure whether Canadians have the capacity to act in a way that results can be achieved. Measuring whether knowledge-based actions are being implemented at community levels is one way of assessing not only whether people have access to the knowledge but also have the capacity to act on it.
RELEVANCE FOR INDIGENOUS PEOPLES	It will be possible to identify adaptation actions that stem from the inclusion of Indigenous Knowledge Systems.
LIMITATIONS	Requires a definition of community and what it includes. Detection of actions that are classed as knowledge-based.
OVERLAP WITH OTHER CHAPTERS	Chapter 2: Protecting and Improving Human Health and Well-Being Chapter 3: Supporting Particularly Vulnerable Regions Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 5: Building Climate Resilience through Infrastructure
POTENTIAL DATA SOURCES	Federal, provincial, territorial, and municipal support for adaptation actions National bodies (eg. Federation of Canadian Municipalities, Inuit Tapiriit Kanatami, Assembly of First Nations, Métis National Council etc.) that are already tracking whether the groups they represent are implementing actions Surveys, etc.
REFERENCES/MORE INFORMATION	

52. Number of federal and territorial/provincial cumulative risk assessments and other environmental assessments that incorporate projections of future climate

FACTORS TO CONSIDER	
RATIONALE	This indicator seeks to track whether cumulative risk assessments and environmental assessments are explicitly considering climate change. It is important to consider cumulative risk assessments because ecosystem health is a crucial factor in resilience to climate change impacts such as flooding and extreme heat, and assessing projects based on individual risk assessments does not capture the accumulation of effects on ecosystems and built landscapes. There is increasing understanding therefore that individual risk assessments do not provide an adequate picture of the overall effects of projects, combined with the short and long term effects of climate change, including effects on the health of both humans and biodiversity. It is equally important that environmental assessments for projects incorporate recognition of climate change impacts as many of them are simply based on current conditions and do not take into account the challenges that will be posed by climate change in the near and long-term future. This has significant implications for projects that will have impacts on water bodies, forests and other ecosystem components.
METRIC USED	Number of cumulative risk assessments and environmental assessments that explicitly consider climate change
BASELINE	Total number of cumulative risk assessments and environmental assessments
CONTEXTUAL INFORMATION	Environmental assessments and cumulative risk assessments are powerful tools to help mainstream adaptation and consider climate risks before projects are developed. Guidelines that come from Canadian Environmental Assessment Agency as well as provinces and territories are slowly making stronger requirements for the inclusion/reference of climate change and impacts.
RELEVANCE FOR INDIGENOUS PEOPLES	Cumulative risk assessments and environmental assessments can be done in all regions and can be applied in all areas and sectors. Environmental assessments and other cumulative impact assessments can/should incorporate Indigenous Knowledge Systems where appropriate.
LIMITATIONS	The depth and degree (quality) to which climate change is present within environmental assessments.
OVERLAP WITH OTHER CHAPTERS	Chapter 2: Protecting and Improving Human Health and Well-Being Chapter 3: Supporting Particularly Vulnerable Regions Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 5: Building Climate Resilience through Infrastructure
POTENTIAL DATA SOURCES	The Canadian Environmental Assessment Agency publishes on their website the list of environmental assessments and cumulative impact studies for projects submitted to the Canadian Environmental Assessment Agency.

	Provinces and territories have environmental assessment processes and most publish lists of projects submitted to these processes and can provide access to the studies conducted. British Columbia has an advanced cumulative risk assessment framework that is being rolled out now.
REFERENCES/MORE INFORMATION	

53. Percentage of property/casualty insurance policies that incent adaptation

FACTORS TO CONSIDER	
RATIONALE	This indicator seeks to track whether insurance companies and their policies are explicitly considering climate change and promoting actions to reduce risks.
METRIC USED	Proportion of property/casualty insurance policies that incent adaptation
BASELINE	Total number of property/casualty insurance policies that incent adaptation
CONTEXTUAL INFORMATION	Since premiums are set according to levels of risk, insurance policies can help guide behavior to reduce risks. Incentives through rebates or lower premiums can incent action to reduce levels of risk including those posed by climate change.
RELEVANCE FOR INDIGENOUS PEOPLES	
LIMITATIONS	Lack of insurance in some places/for some groups
OVERLAP WITH OTHER CHAPTERS	Chapter 2: Protecting and Improving Human Health and Well-Being Chapter 3: Supporting Particularly Vulnerable Regions Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 5: Building Climate Resilience through Infrastructure
POTENTIAL DATA SOURCES	Insurance companies, Insurance Bureau of Canada, Institute for Catastrophic Loss Reduction
REFERENCES/MORE INFORMATION	

54. Percentage of federal, provincial, territorial, and municipal or non-governmental organization funding allocated to implementation of adaptation actions

FACTORS TO CONSIDER	
RATIONALE	This indicator seeks to track the proportion of funding dedicated to support knowledge-based implementation of adaptation actions. Sustained funding for implementation of adaptation actions, provided by programs that ensure equality in project design, is an essential incentive to advance the implementation of adaptation. Appropriate deployment of funds will inform decisions that account for climate change.
METRIC USED	Percentage of multi-year funding from federal/provincial/territorial/municipal government/non-governmental organizations to support knowledge-based implementation of adaptation actions Percentage of all funding for development projects that require climate risk analyses and adaptation planning before accessing funds
BASELINE	Total funding from federal, provincial, territorial and, municipal or non-governmental organizations for implementation of adaptation actions Total funding for development projects that require climate risk analyses and adaptation planning before accessing funds/total funding for development projects
CONTEXTUAL INFORMATION	Canadians expect all levels of government to identify, resource and direct actions that will reduce risk and provide protection for citizens, with different responsibilities based on jurisdictional levels (e.g., federal, provincial, local and Indigenous). They also look to governments to provide guidance and support for individuals and groups to be able to resource themselves to act appropriately on risk, especially in terms of health, safety, and property.
RELEVANCE FOR INDIGENOUS PEOPLES	Particularly relevant for areas of the country where infrastructure deficits are above average and where more resources will be applied to renew/upgrade infrastructure.
LIMITATIONS	
OVERLAP WITH OTHER CHAPTERS	Chapter 2: Protecting and Improving Human Health and Well-Being Chapter 3: Supporting Particularly Vulnerable Regions Chapter 4: Reducing Climate-Related Hazards and Disaster Risks Chapter 5: Building Climate Resilience through Infrastructure
POTENTIAL DATA SOURCES	Infrastructure Canada's forthcoming Climate Lens Federal/provincial/territorial/municipal support for adaptation actions (e.g., Natural Resources Canada, Infrastructure Canada, Federation of Canadian Municipalities) National bodies that are already tracking whether the groups they represent are implementing actions Surveys, etc.
REFERENCES/MORE INFORMATION	